M 69/4

United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Michigan Department of
Agriculture,
Michigan Agricultural
Experiment Station, and
Michigan Technological
University

Soil Survey of Missaukee County, Michigan

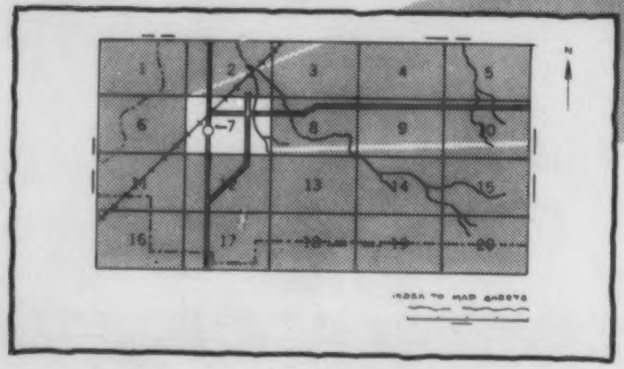
NEWARK PUBLIC LIBRARY
JAN 21 1981
U. S. GOVT. PUBS.
DEPOSITORY 376

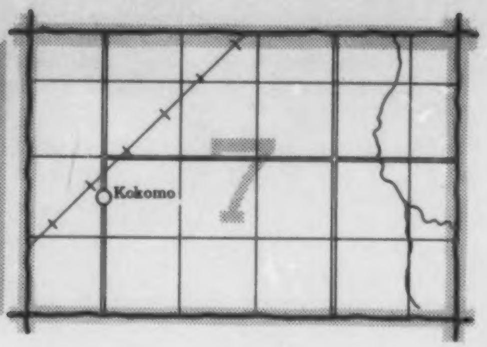
A 57.38:

READEX

HOW TO USE THIS SOIL SURVEY

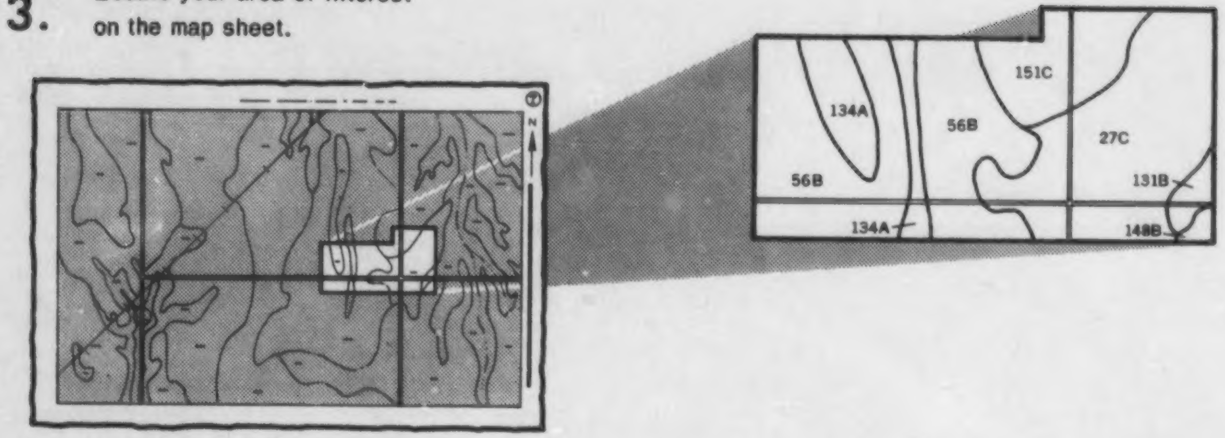
1. Locate your area of interest on the "Index to Map Sheets."


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
N
INDEX TO MAP SHEETS

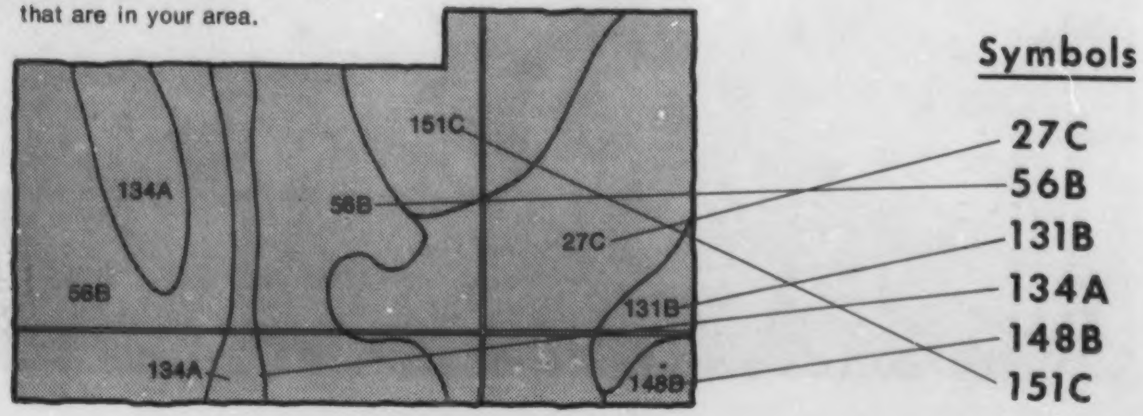


2. Note the number of the map sheet and turn to that sheet.

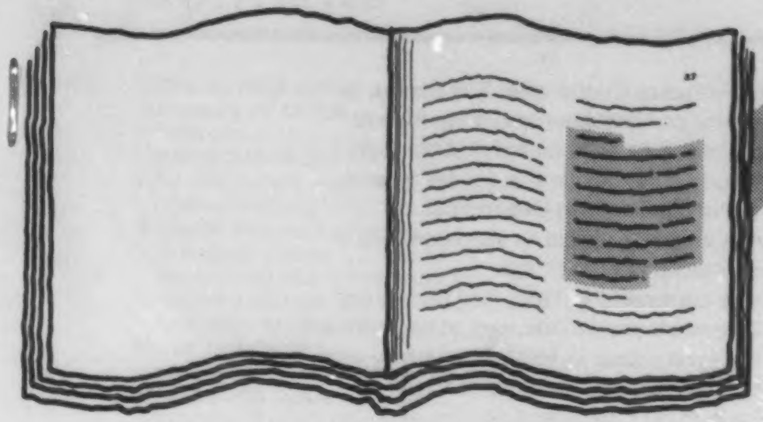
3. Locate your area of interest on the map sheet.

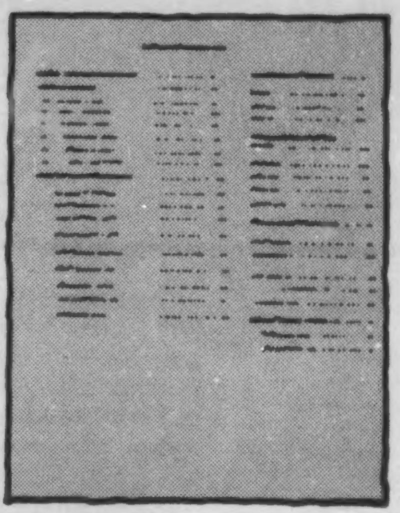

N
151C
134A
56B
27C
56B
131B
134A
148B

4. List the map unit symbols that are in your area.

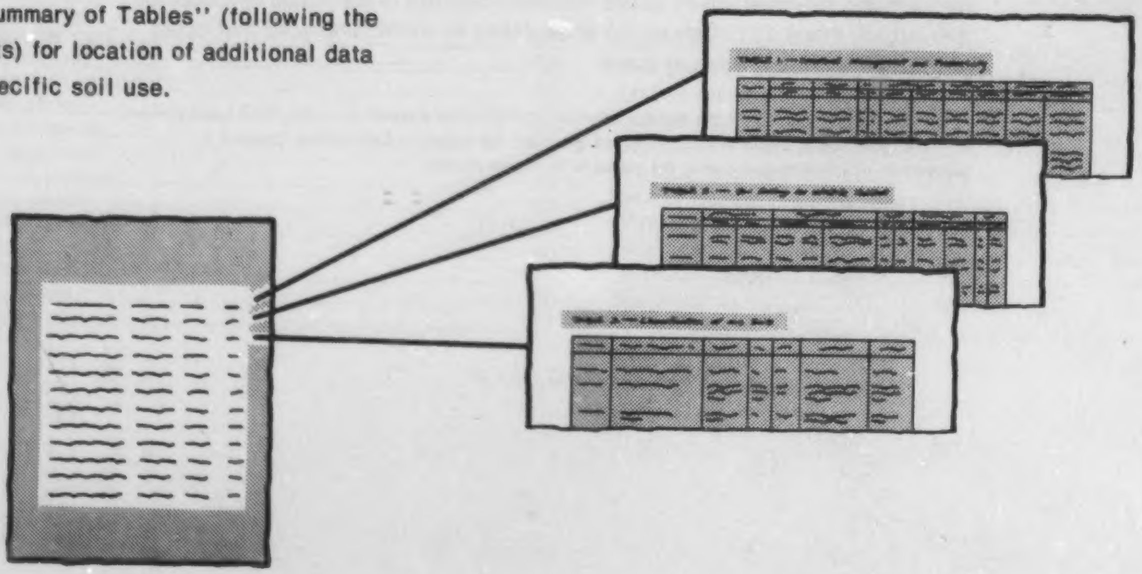

151C
134A
56B
27C
56B
131B
134A
148B
Symbols
27C
56B
131B
134A
148B
151C

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.





6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or *homebuyers;* for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1982. Soil names and descriptions were approved in 1983. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1982. This survey was made by the Soil Conservation Service in cooperation with the Michigan Department of Agriculture, Michigan Agricultural Experiment Station, and Michigan Technological University. It is part of the technical assistance furnished to the Missaukee Soil Conservation District. Financial assistance was made available by the Missaukee County Board of Commissioners.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: A typical area of the Nester-Kawkawlin-Manistee association. Hay has been cut on some of the fields. The soils are some of the best for crops in Missaukee County. A plantation of Christmas trees is on a rise in the foreground.

Contents

Index to map units iv
Summary of tables v
Foreword vii
General nature of the county 1
How this survey was made 4
  Map unit composition 4
General soil map units 7
  Soil descriptions 7
  Broad land use considerations 13
Detailed soil map units 15
  Soil descriptions 15
Prime farmland 45
Use and management of the soils 47
  Crops and pasture 47
  Woodland management and productivity 50
  Windbreaks and environmental plantings 53
  Recreation 53
  Wildlife habitat 54
  Engineering 55
Soil properties 61
  Engineering index properties 61
  Physical and chemical properties 62
  Soil and water features 63
  Soil characterization data 64
Classification of the soils 65
Soil series and their morphology 65
Formation of the soils 79
  Factors of soil formation 79
  Processes of soil formation 80
References 83
Glossary 85
Tables 93

Soil Series

AuGres series 65
Brevort series 66
Carbondale series 66
Cathro series 67
Croswell series 67
Dighton series 68
East Lake series 68
Emmet series 69
Gladwin series 69
Graycalm series 70
Grayling series 70
Iosco series 70
Kalkaska series 71
Kawkawlin series 72
Kawkawlin Variant 72
Loxley series 72
Lupton series 73
Manistee series 73
Montcalm series 74
Nester series 74
Otisco series 75
Roscommon series 75
Rubicon series 76
Sims series 76
Tawas series 77

Issued December 1985

Index to Map Units

3A—Croswell sand, 0 to 3 percent slopes 15
5B—Emmet-Montcalm complex, 0 to 6 percent slopes 16
5C—Emmet-Montcalm complex, 6 to 12 percent slopes 17
5E—Emmet-Montcalm complex, 12 to 30 percent slopes 18
6B—Kalkaska sand, 0 to 6 percent slopes 18
6C—Kalkaska sand, 6 to 12 percent slopes 20
6E—Kalkaska sand, 12 to 30 percent slopes 20
7—Lupton muck 21
10B—Manistee loamy sand, 0 to 6 percent slopes 22
10C—Manistee loamy sand, 6 to 12 percent slopes 22
11B—Montcalm-Graycalm complex, 0 to 6 percent slopes 23
11C—Montcalm-Graycalm complex, 6 to 12 percent slopes 24
11E—Montcalm-Graycalm complex, 12 to 30 percent slopes 25
12B—Nester sandy loam, 1 to 6 percent slopes 25
12C—Nester sandy loam, 6 to 12 percent slopes 26
13B—Rubicon sand, 0 to 6 percent slopes 27
13C—Rubicon sand, 6 to 12 percent slopes 28
13E—Rubicon sand, 12 to 30 percent slopes 29
14A—Otisco loamy sand, 0 to 3 percent slopes 29
15B—East Lake-Rubicon sands, 0 to 6 percent slopes 30
15C—East Lake-Rubicon sands, 6 to 12 percent slopes 31
15E—East Lake-Rubicon sands, 12 to 30 percent slopes 31
16A—AuGres loamy sand, 0 to 3 percent slopes 32
17—Carbondale muck 32
19B—Grayling sand, 0 to 6 percent slopes 33
20—Tawas mucky peat 33
22—Roscommon mucky sand 34
23A—Kawkawlin Variant sandy loam, 0 to 3 percent slopes 34
30—Brevort loamy sand 35
34A—Gladwin loamy sand, 0 to 3 percent slopes 36
36B—Dighton sandy loam, 1 to 6 percent slopes 36
37—Sims loam 37
40A—Iosco loamy sand, 0 to 3 percent slopes 37
42B—Graycalm-Rubicon sands, 0 to 6 percent slopes 39
42C—Graycalm-Rubicon sands, 6 to 12 percent slopes 40
42E—Graycalm-Rubicon sands, 12 to 30 percent slopes 41
46—Loxley mucky peat 41
50A—Kawkawlin loam, 0 to 3 percent slopes 41
53—Cathro muck 43
64—Fluvaquents and Histosols, frequently flooded 43
65—Pits, sand and gravel 43
66—Udipsamments, nearly level 43

Summary of Tables

Temperature and precipitation (table 1) 94

Freeze dates in spring and fall (table 2) 95

Probability. Temperature.

Growing season (table 3) 96

Acreage and proportionate extent of the soils (table 4) 97

Acres. Percent.

Land capability and yields per acre of crops (table 5) 98

Land capability. Corn. Corn silage. Oats. Winter wheat. Grass-legume hay. Grass hay.

Capability classes and subclasses (table 6) 100

Total acreage. Major management concerns.

Woodland management and productivity (table 7) 101

Ordination symbol. Management concerns. Potential productivity. Trees to plant.

Windbreaks and environmental plantings (table 8) 107

Recreational development (table 9) 110

Camp areas. Picnic areas. Playgrounds. Paths and trails. Golf fairways.

Wildlife habitat (table 10) 114

Potential for habitat elements. Potential as habitat for—Openland wildlife, Woodland wildlife, Wetland wildlife.

Building site development (table 11) 117

Shallow excavations. Dwellings without basements. Dwellings with basements. Small commercial buildings. Local roads and streets. Lawns and landscaping.

Sanitary facilities (table 12) 121

Septic tank absorption fields. Sewage lagoon areas. Trench sanitary landfill. Area sanitary landfill. Daily cover for landfill.

Construction materials (table 13) 125

Roadfill. Sand. Gravel. Topsoil.

Water management (table 14) 128

Limitations for—Pond reservoir areas; Embankments, dikes, and levees; Aquifer-fed excavated ponds. Features affecting—Drainage, Irrigation, Grassed waterways.

Engineering index properties (table 15) 131

Depth. USDA texture. Classification—Unified, AASHTO. Fragments greater than 3 inches. Percentage passing sieve number—4, 10, 40, 200. Liquid limit. Plasticity index.

Physical and chemical properties of the soils (table 16) 134

Depth. Clay. Moist bulk density. Permeability. Available water capacity. Soil reaction. Shrink-swell potential. Erosion factors. Wind erodibility group. Organic matter.

Soil and water features (table 17) 136

Hydrologic group. Flooding. High water table. Potential frost action. Risk of corrosion.

Classification of the soils (table 18) 138

Family or higher taxonomic class.

Foreword

This soil survey contains information that can be used in land-planning programs in Missaukee County, Michigan. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

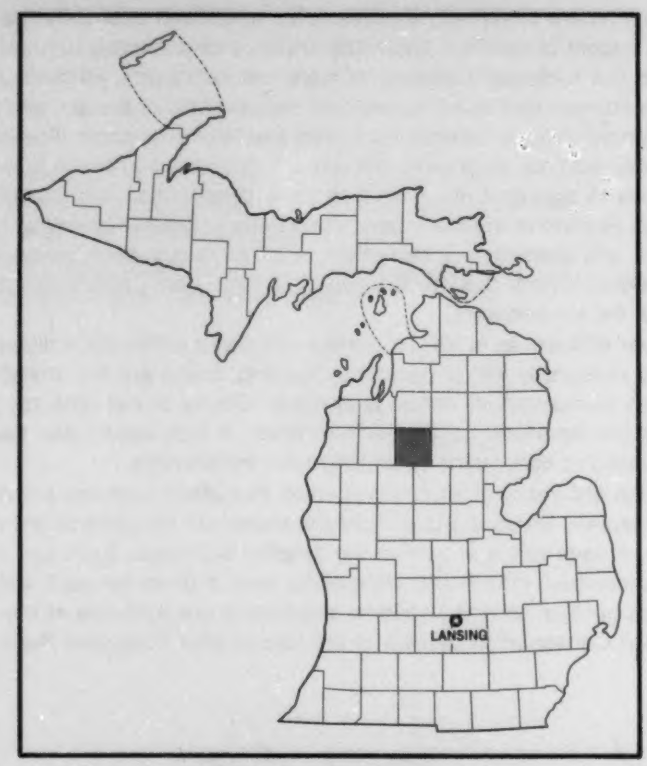
This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Homer R Hilner

Homer R. Hilner
State Conservationist
Soil Conservation Service



Location of Missaukee County in Michigan.

Soil Survey of
Missaukee County, Michigan

By William E. Frederick, Soil Conservation Service

Fieldwork by Joseph Dumont, William E. Frederick, Christine Lietzau, and
Stephen Tardy, Soil Conservation Service, and
Larry Perreault, Michigan Department of Agriculture

United States Department of Agriculture, Soil Conservation Service
In cooperation with the Michigan Department of Agriculture,
Michigan Agricultural Experiment Station, and
Michigan Technological University

MISSAUKEE COUNTY is in the northwest quarter of Michigan's Lower Peninsula. The county is bordered on the north by Kalkaska County, on the east by Roscommon County, on the south by Osceola and Clare Counties, and on the west by Wexford County. Missaukee County covers an area of 366,080 acres, or about 572 square miles. Lake City is the county seat, and it has a population of about 850.

Farming is the main income producing enterprise in the county. Timber production, including Christmas trees, also contributes to the economy in the county and is steadily increasing in importance. Natural gas and oil production also is important, and its importance is expected to increase. Currently, there are two large gas and oil fields operating in the county; one is in the south-central part, and the other is in the northeastern part.

About 59 percent of the acreage in the county is forested, 24 percent is used for agriculture, and 17 percent is in other uses, including recreation and transportation.

General Nature of the County

This section gives general information about Missaukee County. It discusses history and development, farming, physiography and relief, drainage, and climate.

History and Development

Missaukee County was established in 1840. It was once a part of Antrim and Grand Traverse Counties (*6*). Missaukee County was named after an Ottawa Indian Chief.

Settlement of the county began in about 1865, mainly by those interested in the timber resources. Many of the early settlers were Dutch immigrants who worked in the logging industry. They built many camps and towns but abandoned them when the timber resources were exhausted. As the logging boom declined, many people left Missaukee County and followed the timber industry to other parts of the state. The people that stayed established farms on the better soils. Dairy and livestock farming, tourism, and Christmas tree farming have become the dominant economic factors since the end of the logging era.

Farming

Since the homestead settlements of the 1860's and 1870's, farming has been the major source of income in Missaukee County. After the logging industry moved west, settlers came in to farm the cleared land. The early farmers grew corn, oats, potatoes, wheat, rye, sugar beets, and fruit. Most of the farms, then as now, relied on livestock and dairy production. Many farms failed because of the climate and the poor soil conditions.

Today, the good cropland soils in the southwestern, southern, and central parts of the county are farmed. Dairy farming is dominant. Dairy farming adapts well to the northern climate. Most of the crops grown in the county are used as feed on livestock and dairy farms. Grasses and legumes are grown for pasture. Hay covers

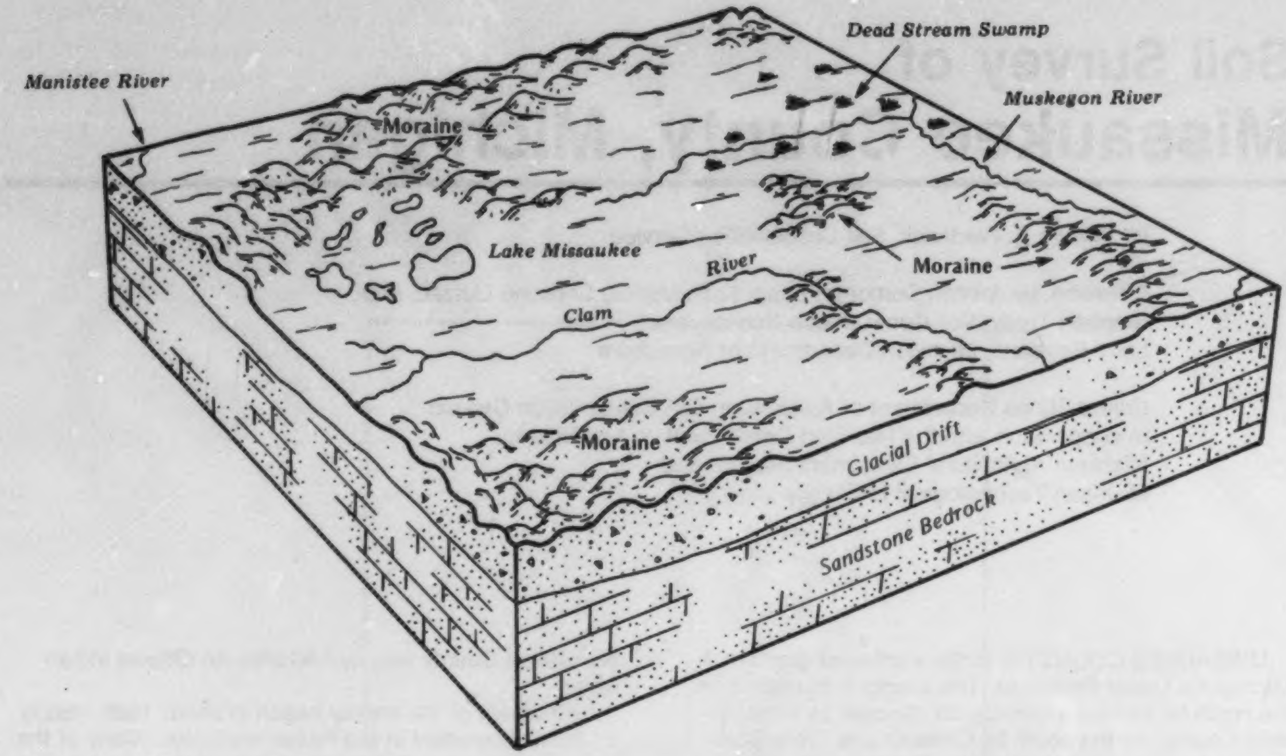


Figure 1.—Physiography of Missaukee County, Michigan.

much of the open farmland. Many areas that were once cropland are now Christmas tree farms. Christmas tree production in Missaukee County contributes to the agricultural base and economic health of the area.

Physiography and Relief

The four distinct kinds of surface features in Missaukee County formed through the complex action of glaciers. These features are moraines, till plains, outwash plains, and ponded areas (fig. 1).

There are several morainic areas in the county. They are distinguished by rolling to steep, uneven, knoblike hills and pothole depressions. The largest of these morainic areas extends northeasterly from the western edge of Caldwell Township to the northern part of West Norwich Township. Another large area extends west from near the city of McBain to the county line. It takes in most of Richland Township. Smaller morainic areas are near the center of the county and also near the southeastern corner of the county.

Till plains and outwash plains are intermingled throughout the county. The soils on the till plains are medium textured to fine textured. A variety of soils are associated with the outwash plains, but most of the soils have a high percentage of sand in the underlying material.

Ponded areas are associated with most river and creek channels. The Dead Stream Swamp is a large ponded area in East Norwich and Enterprise Townships.

The highest elevation, about 1,525 feet above sea level, is in Richland Township. The lowest elevation, about 965 feet above sea level, is in Bloomfield Township.

Drainage

Missaukee County has three major drainage systems. These are the Manistee River, the Muskegon River, and the Clam River.

The Manistee River flows southwesterly across the northwest corner of the county. The Muskegon River and its tributaries drain the northeastern and central parts of the county. The major tributaries of the Muskegon River are the Dead Stream, Addis Creek, Haymarsh Creek, and Butterfield Creek.

The Clam River and its tributaries drain the southwestern part of the county. The Clam River flows southeasterly through the townships of Lake and Clam Union and empties into the Muskegon River outside of the county.

The largest lake in the county is Lake Missaukee. It is approximately 1,900 acres in size. There are about 20 smaller lakes in the county. Many of these lakes are concentrated in the townships of Caldwell and Lake. Several county parks and state forest campgrounds border the lakes.

Climate

Climatic data in this section were specially prepared for the Soil Conservation Service by the Michigan Department of Agriculture, Climatology Division, East Lansing, Michigan.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Lake City and Houghton Lake in the period 1951-80. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Lake City

In winter the average temperature is 19.5 degrees F, and the average daily minimum temperature is 10.6 degrees. The lowest temperature on record, which occurred at Lake City on February 11, 1899, is -41 degrees. In summer the average temperature is 65.2 degrees, and the average daily maximum temperature is 78.6 degrees. The highest recorded temperature, which occurred at Lake City on July 11 and 12, 1936, is 106 degrees.

The total annual precipitation is 28.87 inches. Of this, 18.16 inches, or 63 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 15.6 inches. The heaviest 1-day rainfall during the period of record was 6.77 inches at Lake City on July 8, 1957. Thunderstorms occur on about 35 days each year, and most occur in July. The wettest month was April 1929 with 11.71 inches of precipitation. The driest month, with only a trace of precipitation, was June 1901.

The average seasonal snowfall is 78.5 inches. The greatest snow depth at any one time during the period of record was 40 inches on February 28 and March 1, 1904. On an average of 110 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year. The greatest seasonal snowfall was 123.5 inches in the winter of 1970. The lowest seasonal snowfall was 25.1 inches in 1960-61. The heaviest 1-day snowfall on record was 18 inches on January 22, 1898. The greatest snowfall in 1 month was 63 inches in February 1908.

According to data from the National Weather Service Office at Houghton Lake, the average relative humidity in midafternoon is about 62 percent. Humidity is higher at night, and the average at dawn is about 84 percent. The prevailing wind is from the west-southwest. Average windspeed is highest, 10 miles per hour, in December.

Houghton Lake

In winter the average temperature is 20.1 degrees F, and the average daily minimum temperature is 11.5 degrees. The lowest temperature on record, which occurred at Houghton Lake on February 1, 1918, is -48 degrees. In summer the average temperature is 65.6 degrees, and the average daily maximum temperature is 78.3 degrees. The highest recorded temperature, which occurred at Houghton Lake on June 1, 1934, is 107 degrees.

The total annual precipitation is 29.1 inches. Of this, 17.8 inches, or 61 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 14.6 inches. The heaviest 1-day rainfall during the period of record was 5.18 inches at Houghton Lake on July 8, 1957. Thunderstorms occur on about 28 days each year, and most occur in July. The wettest month was October 1951 with 8.38 inches of precipitation. In the driest month, September 1979, there was not even a trace of precipitation.

The average seasonal snowfall is 60.4 inches. The greatest snow depth at any one time during the period of record was 35 inches in February, 1929. On an average of 108 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year. The greatest seasonal snowfall was 124.1 inches in the winter of 1970-71. The lowest seasonal snowfall was 24.0 inches in 1936-37. The heaviest 1-day snowfall on record was 14.5 inches.

According to data from the National Weather Service Office at Houghton Lake (Roscommon County Airport), the average relative humidity in midafternoon is about 64 percent. Humidity is higher at night, and the average at dawn is about 85 percent. The sun shines 68 percent of the time possible in summer and 32 percent in winter. The prevailing wind is from the southwest. Average windspeed is highest, 10.1 miles per hour, in January.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

[illegible]

[illegible]

[illegible]

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Some of the boundaries on the soil maps of Missaukee County do not match those on the soil maps of adjacent counties, and some of the soil names and descriptions do not fully agree. The differences are a result of improvements in the classification of soils, particularly modification or refinements in soil series concepts. Also, there may be differences in the intensity of mapping or in the extent of the soils within the survey area.

Soil Descriptions

Nearly level to steep soils that are well drained, somewhat excessively drained, and excessively drained

Most of these soils are used as woodland. Some are used for crops and pasture. The soils are suited to trees and poorly suited to crops and pasture. The major concerns in woodland management are equipment limitations and seedling mortality. If the soils are cultivated, soil blowing and droughtiness are the main management concerns.

The soils are suited to building site development; however, slope is a limitation in some areas. Most of the soils can readily absorb the effluent in a septic tank absorption field, but they cannot adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water.

1. Rubicon-Montcalm-Graycalm Association

Nearly level to steep, well drained and somewhat excessively drained sandy soils on outwash plains, till plains, and moraines

This association makes up about 55 percent of the county. It consists of about 35 percent Rubicon soils and similar soils, 30 percent Montcalm soils and similar soils, 20 percent Graycalm soils and similar soils, and 15 percent soils of minor extent.

Rubicon, Montcalm, and Graycalm soils are in similar positions on the landscape. They are on plains, ridges, and hills.

Rubicon soils are somewhat excessively drained. The slope is 0 to 30 percent. Typically, the surface layer is very dark gray and grayish brown sand about 5 inches thick. The subsoil is reddish brown and yellowish brown, loose sand about 19 inches thick. The substratum to a depth of 60 inches is light yellowish brown, loose sand.

Montcalm soils are well drained. The slope is 0 to 30 percent. Typically, the surface layer is very dark gray and pinkish gray loamy sand about 7 inches thick. The subsoil is dark brown and yellowish brown, very friable loamy sand about 14 inches thick. The next layer is yellowish brown, very friable loamy sand about 9 inches thick. Below that, and to a depth of 60 inches, there are alternate bands of light yellowish brown sand and dark brown sandy loam.

Graycalm soils are somewhat excessively drained. The slope is 0 to 30 percent. Typically, the surface layer is very dark gray sand about 2 inches thick. The subsoil is strong brown and yellowish brown, loose sand about 22 inches thick. The next layer is light yellowish brown, loose sand about 20 inches thick. Below that, and to a depth of 60 inches, there are alternate bands of light yellowish brown, loose sand and dark brown loamy sand and sandy loam.

The minor soils are moderately well drained Croswell soils, poorly drained or very poorly drained Roscommon soils, and very poorly drained Lupton and Tawas soils. Croswell soils are slightly lower on the landscape than the major soils. Generally, they are adjacent to drainageways and swampy areas. Roscommon, Lupton, and Tawas soils are in depressions, in drainageways, and in potholes.

The soils making up this association are used mainly as woodland. Some of the nearly level to gently rolling soils are used as cropland or pasture. Seedling mortality is the main limitation to use as woodland. Droughtiness and soil blowing are the main limitations to use as cropland.

The soils are well suited to trees. Because the soils are droughty and susceptible to erosion and soil blowing, they are only fairly well suited or poorly suited to cultivated crops and pasture and to recreation uses. Because of slope and poor filtering capacity, the soils are only fairly well suited to use as building sites and septic tank absorption fields.

2. Kalkaska Association

Nearly level to steep, somewhat excessively drained sandy soils on outwash plains and moraines

This association makes up about 3 percent of the county. It consists of about 60 percent Kalkaska soils and similar soils and 40 percent soils of minor extent.

Kalkaska soils are on plains, ridges, and hills. These soils are somewhat excessively drained. The slope is 0 to 30 percent. Typically, the surface layer is black sand and leaf litter about 3 inches thick. The subsoil is about 34 inches thick. The upper part is dark reddish brown, very friable or loose sand; the middle part is strong brown, loose sand; the lower part is yellowish brown, loose sand. The substratum to a depth of 60 inches is light yellowish brown, loose sand.

The minor soils are well drained Montcalm soils and somewhat poorly drained AuGres soils. The Kalkaska and Montcalm soils are in similar positions on the landscape. AuGres soils are in lower positions, generally adjacent to drainageways and swampy areas.

The soils making up this association are used mainly as woodland. Some of the nearly level to undulating soils are used as cropland or pasture. Seedling mortality is the main limitation to use as woodland. Droughtiness and soil blowing are the main limitations to use as cropland.

The soils are well suited to trees. Because the soils are droughty and susceptible to erosion and soil blowing, they are poorly suited to cultivated crops and pasture and to recreation uses. Because of slope and poor filtering capacity, the soils are only fairly well suited to building site development and to use as septic tank absorption fields.

3. Grayling Association

Nearly level to undulating, excessively drained sandy soils on outwash plains

This association makes up about 1 percent of the county. It consists of about 70 percent Grayling soils and 30 percent soils of minor extent.

Grayling soils are excessively drained. The slope is 0 to 6 percent. Typically, the surface layer is black sand about 3 inches thick. The subsoil is about 25 inches thick. The upper part of the subsoil is dark yellowish brown, very friable sand, and the lower part is yellowish brown, loose sand. The substratum to a depth of 60 inches is light yellowish brown, loose sand.

The minor soils are moderately well drained Croswell soils, somewhat excessively drained Graycalm soils, and excessively drained Rubicon soils. Croswell soils are slightly lower on the landscape than the Grayling soils. Generally, the Croswell soils are adjacent to drainageways and swampy areas. Graycalm and Rubicon soils and the Grayling soils are in similar positions.

The soils making up this association are used mainly as woodland. Extreme droughtiness is the major problem, and soil blowing is a hazard in cleared areas. Seedling mortality is the main limitation to use as woodland.

The soils are generally not suited to cultivated crops and pasture. Because of extreme droughtiness, the soils are poorly suited to use as woodland. Because of poor filtering capacity, the soils are only fairly well suited to recreation uses. The soils are well suited to building site development and to use as septic tank absorption fields.

Nearly level to steep soils that are well drained, somewhat poorly drained, and poorly drained

Most of these soils are used as cropland. Some are used as woodland. The soils generally are suited to use as cropland and pasture. If the soils are cultivated, soil blowing and water erosion are hazards. Removing excess water during wet periods and maintaining good soil tilth are concerns in management.

The major concerns in woodland management are equipment limitations on wet soils and on soils where the slope is more than 18 percent. Seedling mortality is a concern on the sandy soils and on the very wet soils.

The well drained soils are suited to building site development; however, slope is a limitation in some areas. Most of the soils are poorly suited to use as septic tank absorption fields because of permeability and wetness.

4. Emmet-Montcalm Association

Nearly level to steep, well drained loamy and sandy soils on moraines and till plains.

This association makes up about 3 percent of the county. It consists of about 35 percent Emmet soils and similar soils, 35 percent Montcalm soils and similar soils, and 30 percent soils of minor extent.

Emmet and Montcalm soils are in similar positions on the landscape. They are on knolls, ridges, and hills (fig. 2).

Emmet soils are well drained. The slope is 0 to 30 percent. Typically, the surface layer is dark grayish brown sandy loam about 9 inches thick. The upper part of the subsoil is dark brown friable sandy loam about 8 inches thick. The middle part is brown, very friable sandy loam about 5 inches thick. The lower part of the subsoil is dark brown, friable sandy loam about 21 inches thick.

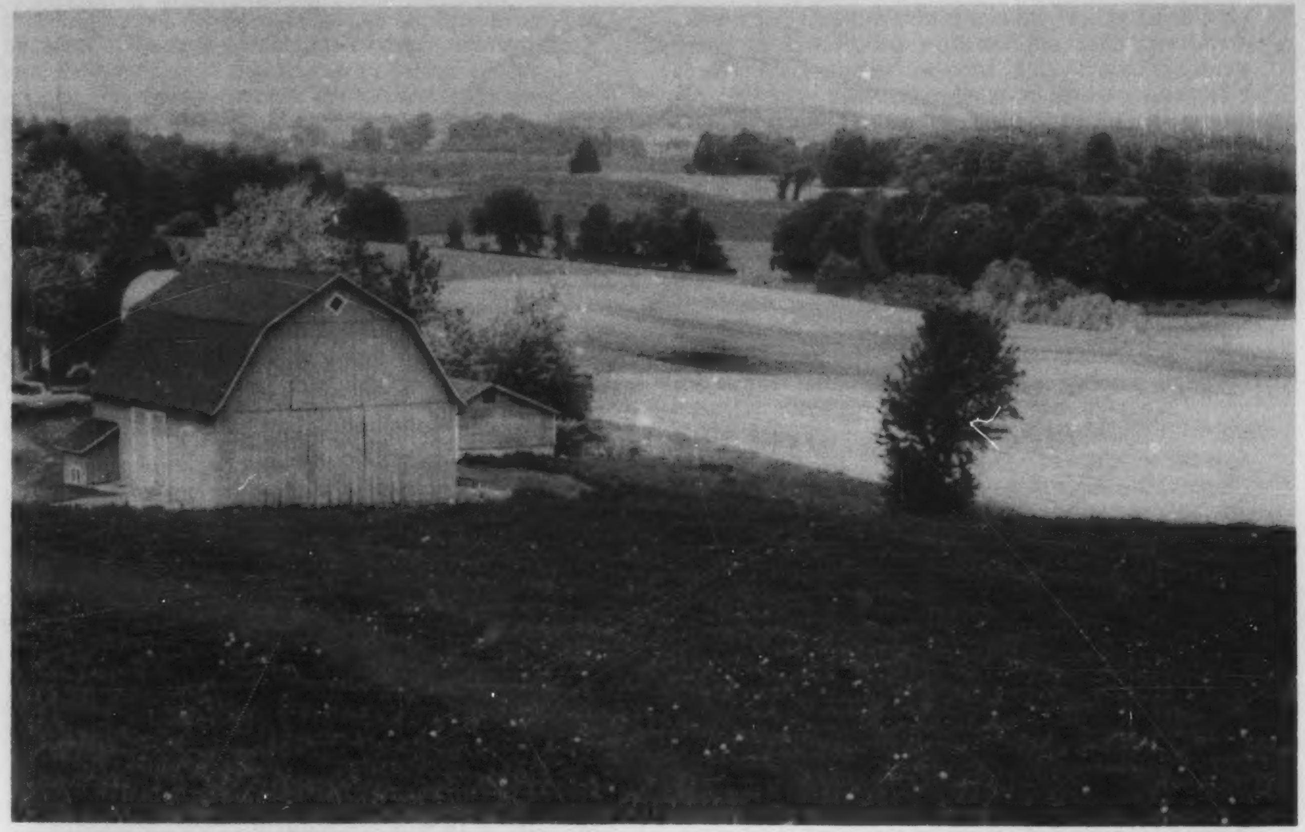


Figure 2.—The soils that make up the Emmet-Montcalm association typically are on knolls, ridges, and hills.

The substratum is pale brown, friable sandy loam to a depth of 60 inches or more.

Montcalm soils are well drained. The slope is 0 to 30 percent. Typically, the surface layer is very dark grayish brown and pinkish gray loamy sand about 7 inches thick. The subsoil extends to a depth of about 60 inches. In the upper part it is dark brown and yellowish brown, very friable loamy sand. In the lower part the subsoil is light yellowish brown, loose sand and bands of dark brown, friable sandy loam.

The minor soils are somewhat excessively drained Graycalm soils and well drained Nester soils. Graycalm and Nester soils are in positions on the landscape similar to those of the Emmet and Montcalm soils. Graycalm soils are more droughty than the Emmet and Montcalm soils, and Nester soils are less droughty.

The soils making up this association are used mainly as cropland or pasture. Some of the steeper soils are used as woodland. Steep slopes and the hazard of erosion are the main limitations to use of the soils for crops and for most other uses. In addition, Montcalm soils are droughty.

The nearly level and gently undulating soils in this association are well suited to use as cropland, pasture, and woodland. These soils are also well suited to recreation uses, to building site development, and to use as septic tank absorption fields.

The rolling to steep soils are well suited to use as woodland. They are fairly well suited to poorly suited to crops or pasture, to recreation uses and building site development, and to use as septic tank absorption fields.

5. Nester-Kawkawlin-Manistee Association

Nearly level to gently rolling, well drained and somewhat poorly drained loamy and sandy soils on till plains and moraines

This association makes up about 9 percent of the county. It consists of about 30 percent Nester soils and similar soils, 25 percent Kawkawlin soils and similar

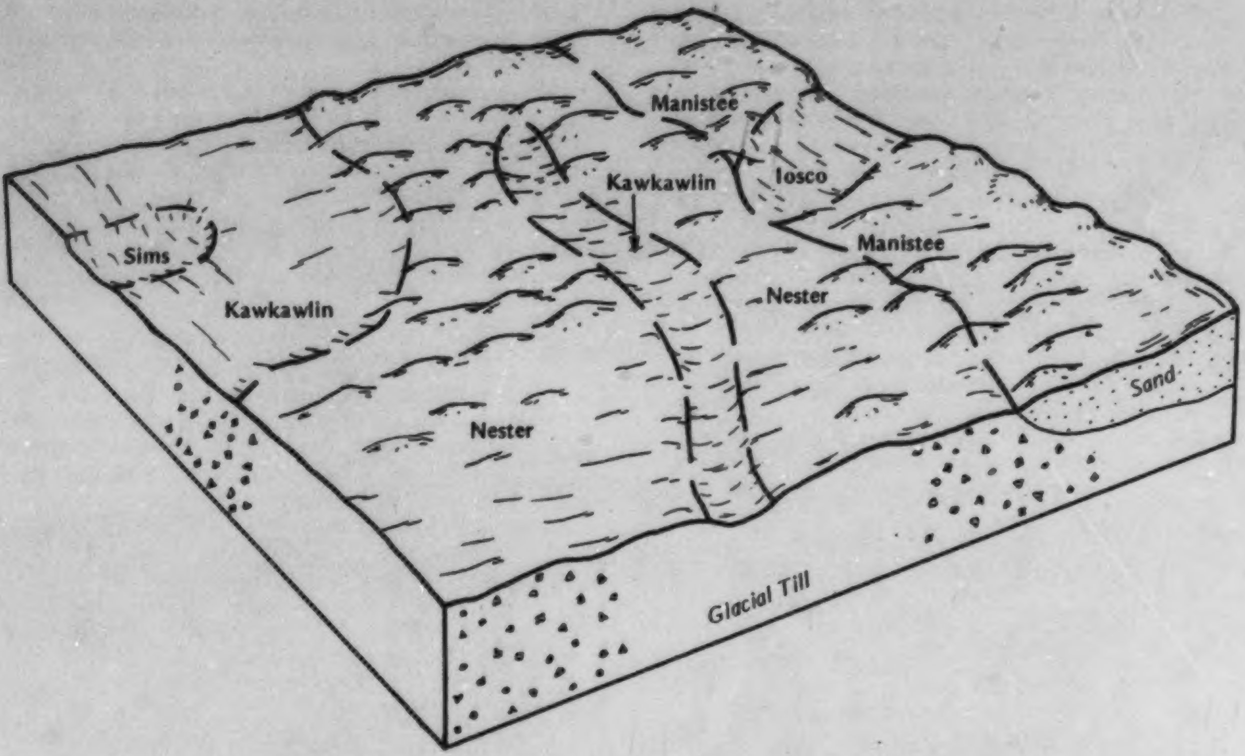


Figure 3.—Pattern of soils and underlying material in the Nester-Kawkawlin-Manistee association.

soils, 10 percent Manistee soils and similar soils, and 35 percent soils of minor extent (fig. 3).

Nester and Manistee soils are in similar positions on the landscape. They are on the higher knolls on till plains, on upland plains, and on ridgetops on moraines. Kawkawlin soils are lower on the landscape. They are in low broad areas and in depressions and drainageways on uplands.

Nester soils are well drained. The slope is 1 to 12 percent. Typically, the surface layer is very dark grayish brown sandy loam about 9 inches thick. The next layer is a mixture of grayish brown sandy loam and dark brown, firm clay loam about 8 inches thick. The subsoil is dark brown, firm clay about 21 inches thick. The substratum to a depth of 60 inches is brown, firm clay loam.

Kawkawlin soils are somewhat poorly drained. The slope is 0 to 3 percent. Typically, the surface layer is dark grayish brown loam about 8 inches thick. The next layer is mottled and mixed, dark brown clay and grayish brown loam about 4 inches thick. The subsoil is brown, mottled, firm clay loam about 23 inches thick. The substratum is yellowish brown, mottled, firm clay loam to a depth of 60 inches or more.

Manistee soils are well drained. The slope is 0 to 12 percent. Typically, the surface layer is dark brown loamy sand about 10 inches thick. The upper part of the subsoil is strong brown, loose sand about 12 inches thick. The middle part is light brownish gray, loose sand about 2 inches thick. The lower part of the subsoil is dark brown, firm clay. The substratum to a depth of 60 inches is brown, firm clay.

The minor soils are Iosco and Sims soils. Iosco soils are somewhat poorly drained. Unlike the Nester and Kawkawlin soils, the Iosco soils are coarse textured throughout, and they are coarser textured in the lower layers than the Manistee soils. Their position on the landscape is similar to that of Kawkawlin soils. Sims soils are poorly drained and are fine textured. They are in drainageways, in low areas, and in depressions.

The soils making up this association are used mainly as cropland or pasture. In some areas they are used as woodland. The wetness of Kawkawlin soils, the susceptibility to soil blowing of Manistee and Nester soils, and permeability are the major problems for most uses. Also, because of the high percentage of clay in the substratum, the shrink-swell potential is moderate. Unless drained, the Kawkawlin soils are too wet for timely planting of crops. Drainage outlets, however, are difficult to locate.

The soils in this association are well suited to fairly well suited to use as cropland. They are well suited to use as pasture and woodland. Nester and Manistee soils are well suited to fairly well suited to recreation uses and building site development. All of the soils are poorly suited to use as septic tank absorption fields because of moderately slow and slow permeability and wetness. The seasonal high water table of Kawkawlin soils is a limitation for most uses.

6. Kawkawlin-Iosco-Sims Association

Nearly level, somewhat poorly drained and poorly drained loamy and sandy soils on till plains

This association makes up about 9 percent of the county. It consists of about 25 percent Kawkawlin soils and similar soils, 25 percent Iosco soils and similar soils, 15 percent Sims soils and similar soils, and 35 percent soils of minor extent.

Kawkawlin and Iosco soils are in similar positions on the landscape. They are in low broad areas and along minor drainageways. Sims soils are lower on the landscape. They are in small depressions and drainageways, and they are subject to ponding.

Kawkawlin soils are somewhat poorly drained. The slope is 0 to 3 percent. Typically, the surface layer is dark grayish brown loam about 8 inches thick. The next layer is mottled and mixed dark brown clay and grayish brown loam about 4 inches thick. The subsoil is dark brown, mottled, firm clay loam about 23 inches thick. The substratum is yellowish brown, mottled, firm clay loam to a depth of 60 inches or more.

Iosco soils are somewhat poorly drained. The slope is 0 to 3 percent. Typically, the surface layer is grayish brown loamy sand about 9 inches thick. The subsurface layer is light brownish gray loamy sand about 2 inches thick. The upper part of the subsoil is dark brown, loose sand about 15 inches thick. The middle part is mottled and mixed, dark brown sandy loam and light brownish gray loamy sand about 5 inches thick. The lower part of the subsoil is dark brown, mottled, firm sandy loam about 15 inches thick. The substratum is brown, mottled, firm loam to a depth of 60 inches or more.

Sims soils are poorly drained. The slope is 0 to 2 percent. Typically, the surface layer is very dark gray loam about 8 inches thick. The subsoil is grayish brown, mottled, firm clay loam about 18 inches thick. The substratum is grayish brown and yellowish brown, mottled, firm silty clay loam to a depth of 60 inches or more.

Of minor extent in the association are well drained Nester soils, somewhat poorly drained AuGres soils, poorly drained Brevort soils, and very poorly drained Lupton soils. Nester soils are in the highest positions on the landscape. AuGres soils and the Iosco and Kawkawlin soils are in similar positions. AuGres soils are more droughty than the Kawkawlin soils. Brevort soils and the Sims soils are in similar positions. Brevort soils are coarser textured than the Sims soils. Lupton soils are in the lowest positions on the landscape. They are in deep depressions, drainageways, and potholes.

The soils making up this association are used mainly as cropland or pasture. In some areas they are used as woodland. Wetness and the moderately slow permeability are the main limitations for most uses. Also, because of the high content of clay in the substratum, the shrink-swell potential is moderate. Unless drained, the soils are too wet for timely planting of crops. In some areas, however, drainage outlets are difficult to locate.

The soils are fairly well suited to crops, pasture, and trees. If they are drained, the Kawkawlin soils are well suited to crops. Because of wetness, the soils in the association are poorly suited or not suited to most recreation uses, to building site development, and to use as septic tank absorption fields.

Nearly level soils that are somewhat poorly drained, poorly drained, and very poorly drained

Most of these soils are used as woodland. Some are used for crops and pasture. The soils are suited to trees, crops, and pasture. The major concerns in woodland management are equipment limitations, seedling mortality, and windthrow hazard. If the soils are cultivated, removing excess water, preventing ponding, providing drainage outlets, and controlling soil blowing during dry periods are concerns in management.

The soils generally are not suited to building site development or to use as septic tank absorption fields.

7. AuGres-Iosco-Lupton Association

Nearly level, somewhat poorly drained and very poorly drained sandy and mucky soils on outwash plains and till plains

This association makes up about 5 percent of the county. It consists of about 30 percent AuGres soils and similar soils, 25 percent Iosco soils and similar soils, 15 percent Lupton soils and similar soils, and 30 percent soils of minor extent.

AuGres and Iosco soils are in similar positions on the landscape. They are in low broad areas, in upland depressions, along major drainageways, and adjacent to swamps. Lupton soils are lower on the landscape. They are in depressions, swamps, and drainageways, and they are subject to frequent ponding.

AuGres soils are somewhat poorly drained. The slope is 0 to 3 percent. Typically, the surface layer is very dark gray loamy sand about 7 inches thick. The subsurface layer is pinkish gray loamy sand about 5 inches thick. The subsoil is about 31 inches thick. It is mottled, dark brown loamy sand in the upper part and mottled, yellowish brown sand in the lower part. The substratum is yellowish brown, mottled, loose sand to a depth of 60 inches.

Iosco soils are somewhat poorly drained. The slope is 0 to 3 percent. Typically, the surface layer is grayish brown loamy sand about 9 inches thick. The subsurface layer is light brownish gray loamy sand about 2 inches thick. The upper part of the subsoil is dark brown, loose sand about 15 inches thick. The middle part is mottled and mixed, dark brown sandy loam and light brownish gray loamy sand about 5 inches thick. The lower part of the subsoil is dark brown, mottled, firm sandy loam about 15 inches thick. The substratum is brown, mottled, firm loam to a depth of 60 inches.

Lupton soils are very poorly drained. The slope is 0 to 2 percent. Typically, the surface layer is black muck about 7 inches thick. The underlying layers, to a depth of 60 inches or more, are also black muck.

The minor soils are moderately well drained Croswell soils, somewhat poorly drained loamy Kawkawlin soils, and poorly drained Brevort and Roscommon soils. Croswell soils are slightly higher on the landscape than AuGres and Iosco soils. They are on small ridges and low knolls. Kawkawlin soils and the AuGres and Iosco soils are in similar positions. Brevort and Roscommon soils are in drainageways and depressions.

The soils making up this association are used mainly as woodland. In a few small areas, they are used as pasture or cropland. Wetness is the main limitation. In addition, on AuGres and Iosco soils, droughtiness and soil blowing during dry months are limitations.

The soils are fairly well suited to poorly suited to use as cropland, pasture, and woodland. Because of wetness, they are poorly suited or not suited to recreation uses, to building site development, or to use as septic tank absorption fields.

8. Otisco-Roscommon Association

Nearly level, somewhat poorly drained, poorly drained, and very poorly drained sandy soils on till plains and outwash plains

This association makes up about 2 percent of the county. It consists of about 35 percent Otisco soils and similar soils, 30 percent Roscommon soils and similar soils, and 35 percent soils of minor extent.

Otisco soils are in low broad areas, in upland depressions, along major drainageways, and adjacent to swamps. Roscommon soils are lower on the landscape. They are in depressions, swamps, and drainageways and are subject to frequent ponding.

Otisco soils are somewhat poorly drained. The slope is 0 to 3 percent. Typically, the surface layer is black loamy sand about 3 inches thick. The subsurface layer is grayish brown loamy sand about 5 inches thick. The subsoil is mottled and is about 47 inches thick. The upper part of the subsoil is dark brown, very friable loamy sand. The lower part is light yellowish brown, loose sand and bands of yellowish brown, friable sandy loam. The substratum to a depth of 60 inches is mottled, yellowish brown, loose sand.

Roscommon soils are poorly drained or very poorly drained. The slope is 0 to 2 percent. Typically, the surface layer is black mucky sand about 4 inches thick. The underlying layers to a depth of 60 inches are multicolored, loose sand.

The minor soils are somewhat poorly drained Iosco soils and very poorly drained Tawas soils. Iosco and Tawas soils and Roscommon soils are in similar positions on the landscape. Iosco soils are rapidly permeable in the upper part of the profile and moderately slowly permeable in the lower part. Tawas soils are moderately slowly permeable to moderately rapidly permeable in the muck layer and rapidly permeable in the underlying sand.

The soils making up this association are used mainly as woodland. In a few small areas, they are used as pasture or cropland. Wetness is the main limitation to use as woodland and cropland and for most other uses. Droughtiness and soil blowing during dry periods are additional limitations on the Otisco soils.

The soils are fairly well suited or not suited to use as cropland, pasture, and woodland. Because of wetness, the soils are poorly suited or not suited to recreation uses, to building site development, and to use as septic tank absorption fields.

9. Lupton-Roscommon-Tawas Association

Nearly level, poorly drained and very poorly drained mucky and sandy soils in upland depressions on outwash plains, till plains, and moraines

This association makes up about 13 percent of the county. It consists of about 35 percent Lupton soils and similar soils, 25 percent Roscommon soils and similar soils, 15 percent Tawas soils and similar soils, and 25 percent soils of minor extent.

Lupton and Tawas soils are in similar positions on the landscape. They are in upland and lowland depressions, swamps, and drainageways. Roscommon soils are slightly higher on the landscape. They are in lowland depressions and drainageways and in areas surrounding bogs. All of the soils are subject to frequent ponding.

Lupton soils are very poorly drained. The slope is 0 to 2 percent. Typically, the surface layer is black muck about 7 inches thick. The underlying material to a depth of 60 inches is black muck.

Roscommon soils are very poorly drained. The slope is 0 to 2 percent. Typically, the surface layer is black mucky sand about 4 inches thick. The underlying material to a depth of 60 inches is multicolored, loose sand.

Tawas soils are very poorly drained. The slope is 0 to 2 percent. Typically, the surface layer is very dark brown mucky peat about 4 inches thick. The subsoil is black muck about 18 inches thick. The substratum to a depth of 60 inches is grayish brown, loose sand.

The minor soils are moderately well drained Croswell soils and somewhat poorly drained AuGres and Iosco soils. Croswell soils are on the lower knolls and hills. AuGres and Iosco soils are in slightly higher positions and generally are adjacent to drainageways and swampy areas.

The soils making up this association are used mainly as woodland. In some areas the soils are in marsh grass or are covered with shrubs. In a few areas, the soils are used as pasture. On Lupton and Tawas soils, wetness and soil instability are major limitations for most uses. Most soils are undrained because drainage outlets are very difficult to locate.

Excessive wetness and soil instability are severe limitations and are difficult to overcome. The soils, consequently, generally are not suited to use as cropland, pasture, or woodland or to recreation uses, building site development, or septic tank absorption fields.

Broad Land Use Considerations

The soils in Missaukee County vary widely in their suitability for major land uses.

Cropland

About 18 percent of the land in the county is used for cultivated crops. Cropland is scattered throughout the county and is concentrated in associations 4, 5, and 6. The soils in these associations generally are suited to crops. In association 4, crops are grown on the nearly level to rolling soils. Droughtiness and the hazard of erosion are the main limitations. In associations 5 and 6, the hazards of erosion and soil blowing, removing excess water during wet periods, and maintaining good tilth are concerns in cropland management. The poorly drained soils in association 6 generally are not cultivated. Crops generally are not grown on the soils in associations 1, 2, and 3 because of droughtiness, soil blowing, and steepness of slope. Also, crops generally are not grown on the soils in associations 7, 8, and 9 because of wetness. The instability of the organic soils in associations 7 and 9 is an additional limitation.

Pasture and Hayland

About 2 percent of the land in the county is permanent pasture, and about 4 percent is hayland in a tillage rotation. The soils in associations 4, 5, and 6 generally are suited to use as pasture and hayland. Much of the pasture is on the rolling to steep soils in association 4. Some pasture is on the somewhat poorly drained soils in association 7.

Woodland

About 59 percent of the county is woodland. The sugar maple, beech, and yellow birch forest cover type predominates in associations 2, 4, and 5. In association 1, the oak and red maple forest cover type predominates. The jack pine cover type is exclusive in association 3. In associations 6, 7, and 8, the red maple, paper birch, white spruce, and balsam fir cover type predominates. Northern white-cedar is the forest cover type in association 9. Seedling mortality is the main concern on woodland in Missaukee County. Erosion, equipment limitations, and windthrow hazard are additional management concerns on some soils.

Recreation

The soils in Missaukee County vary from well suited to not suited to use as sites for recreation. The nearly level and gently undulating soils in associations 4 and 5 are well suited to intensive recreation uses, for example, playgrounds, camp areas, picnic areas, and paths and trails. The sandy surface layer of most of the soils in associations 1, 2, and 3 is a limitation for recreation uses. Wetness is the major limitation on the soils in associations 6, 7, and 8. The soils in association 9 generally are not suited to recreation uses because of their extreme wetness and instability.

Wildlife habitat

The soils in associations 1, 2, 3, 4, 5, 6, 7, and 8 generally are suitable for use as habitat for openland and woodland wildlife. The very poorly drained organic soils in associations 7 and 9 and the poorly drained soils in associations 6, 7, 8, and 9 are suitable for use as habitat for wetland wildlife.

Urban land

Generally, the nearly level to rolling soils in association 4 are well suited to building site development, including onsite waste disposal. The limitations are slight to moderate. Slope is the main limitation. The nearly level to rolling soils in associatons 1, 2, and 3 are fairly well suited to use as sites for buildings. The poor filtering capacity is a major limitation to use of these soils as septic tank absorption fields. The well drained, nearly level to rolling soils in association 5 are fairly well suited to most kinds of building site development. The soils in associations 6, 7, 8, and 9 generally are not suited to building site development or to use as septic tank absorption fields because of wetness.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Nester sandy loam, 1 to 6 percent slopes, is one of several phases in the Nester series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Montcalm-Graycalm complex, 0 to 6 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Fluvaquents and Histosols, frequently flooded, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Pits, sand and gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Some of the boundaries on the soil maps of Missaukee County do not match those on the soil maps of adjacent counties, and some of the soil names and descriptions do not fully agree. The differences are a result of improvements in the classification of soils, particularly modification or refinements in soil series concepts. Also, there may be differences in the intensity of mapping or in the extent of the soils within the survey area.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

3A—Croswell sand, 0 to 3 percent slopes. This is a nearly level, moderately well drained soil on low knolls, in depressions, and adjacent to streams and drainageways. The areas are linear or irregular in shape and range from about 5 to 40 acres in size.

Typically, the surface layer is very dark gray and pinkish gray sand about 7 inches thick. The subsoil is about 24 inches thick. The upper part of the subsoil is dark brown, loose sand, and the lower part is strong brown, mottled, loose sand. The substratum to a depth of 60 inches is light yellowish brown, mottled, loose sand.

Included with this soil in mapping are areas of AuGres, Roscommon, and Tawas soils. AuGres soils are somewhat poorly drained. Roscommon soils are poorly drained or very poorly drained. Tawas soils are very poorly drained. The included soils are in depressions and wet swales. These soils make up 5 to 10 percent of the map unit.

Permeability of the Croswell soil is rapid. The available water capacity is low. Runoff is slow. The seasonal high water table is at a depth of 2 to 3 feet in winter and spring.

Most areas of this soil are wooded or are idle. The trees are mainly red pine, quaking aspen, red maple, and northern red oak. In a few areas, the soil is used as cropland or pasture.

This soil is poorly suited to use as cropland because of droughtiness and soil blowing. Only close-growing crops, such as alfalfa and oats and legumes for hay, can be grown. The use of cover crops, green manure crops, crop residue, and manure conserves soil moisture. Cover crops, wind stripcropping, vegetative barriers, and field windbreaks help control soil blowing.

This soil is fairly well suited to pasture. The major management concern is droughtiness. Proper stocking, rotation grazing or strip grazing, and restricted use during excessively dry periods help keep the pasture and soil in good condition.

This soil is well suited to use as woodland. Seedling mortality and equipment limitations are the main management concerns. Good site preparation, the use of containerized seedlings, and the replanting of seedlings help reduce seedling mortality in new plantations. The sandy surface layer affects trafficability during dry periods.

This soil is poorly suited to recreation uses. The major concerns are the sandy surface layer and wetness. However, a layer of medium textured topsoil can make a site suitable for playgrounds or camp areas, and paths and trails can be covered with wood chips or bark to improve footing.

This soil is poorly suited to building site development because of wetness. If the soil is used as a site for buildings, subsurface drains should be used to lower the water table, and well-compacted fill material should be used to raise the site.

This soil is poorly suited to use as septic tank absorption fields because of wetness and poor filtering capacity. Filling or mounding the absorption field site with suitable material may be needed to raise the site above the water table and to increase the filtering capacity of the soil.

The land capability classification of the Croswell soil is IVs. The Michigan soil management group is 5a.

5B—Emmet-Montcalm complex, 0 to 6 percent slopes. This complex consists of nearly level to undulating, well drained soils on broad plains and low knolls. The areas are irregular in shape and range from about 5 to 100 acres or more in size.

The Emmet soil makes up about 35 to 40 percent of the complex, and the Montcalm soil makes up about 35 to 40 percent. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

Typically, the Emmet soil has a dark grayish brown sandy loam surface layer about 9 inches thick. The upper part of the subsoil is dark brown, friable sandy loam about 8 inches thick. The next layer is brown, very friable sandy loam about 5 inches thick. The lower part of the subsoil is dark brown, friable sandy loam about 21 inches thick. The substratum to a depth of 60 inches is pale brown, friable sandy loam. In some places, the surface layer is more than 15 percent pebbles and cobbles. In some places, the soil is moderately well drained.

Typically, the Montcalm soil has a very dark grayish brown and light brownish gray, loamy sand surface layer about 7 inches thick. The subsoil extends to a depth of 60 inches. It is dark brown and yellowish brown, very friable sand in the upper part. The lower part is light yellowish brown, very friable sand with bands of reddish brown sandy loam. In some places, the surface layer is more than 15 percent pebbles and cobbles.

Included with these soils in mapping are small areas of Graycalm, Rubicon, and Nester soils. Graycalm and Rubicon soils are somewhat excessively drained. They are more droughty than the Emmet and Montcalm soils. Nester soils are well drained; they are less droughty than the Emmet and Montcalm soils. The included soils and the Emmet and Montcalm soils are in similar positions on the landscape. The included soils make up 10 to 20 percent of the map unit.

Permeability is moderate in the Emmet soil and moderately rapid in the Montcalm soil. The available water capacity is moderate in the Emmet soil and low in the Montcalm soil. Runoff is slow. The surface layer of the Emmet soil is friable and is easily tilled within a wide range of moisture content.

In most areas, these soils are used as cropland or pasture. In a few areas, they are used as woodland.

These soils are well suited to corn, winter wheat, and oats and to grasses and legumes for hay. Erosion and droughtiness are the major concerns in management. Cover crops, windbreaks, and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface effectively control soil blowing and erosion. The use of cover crops, green manure crops, crop residue, and manure conserves soil moisture.

These soils are well suited to pasture. Droughtiness is the main management concern. Proper stocking, rotation grazing or strip grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

These soils are well suited to use as woodland. Seedling mortality is a concern in management. In some areas, good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations.

These soils are well suited to building site development and to use as septic tank absorption fields. There are no major management concerns.

The land capability classification of these soils is IIe. The Michigan soil management groups are 3a and 4a.

5C—Emmet-Montcalm complex, 6 to 12 percent slopes. This complex consists of gently rolling, well drained soils on ridges, knolls, and side slopes. The areas are irregular in shape and range from about 10 to 200 acres or more in size.

The Emmet soil makes up about 35 to 40 percent of the complex, and the Montcalm soil makes up about 35 to 40 percent. These soils are in areas that are so intricately mixed or are so small that it was not practical to map them separately at the scale used in mapping.

Typically, the Emmet soil has a dark grayish brown, sandy loam surface layer about 7 inches thick. The upper part of the subsoil is dark brown, friable sandy loam about 7 inches thick. The next layer is brown, very friable sandy loam about 4 inches thick. The lower part of the subsoil is dark brown, friable sandy loam about 19 inches thick. The substratum to a depth of 60 inches is pale brown, friable sandy loam. In some places, the surface layer is more than 15 percent pebbles and cobbles.

Typically, the Montcalm soil has a very dark grayish brown and light brownish gray, loamy sand surface layer about 7 inches thick. The subsoil is about 53 inches thick. The upper part of the subsoil is brown and light yellowish brown, very friable sand. The lower part is light yellowish brown, very friable sand with bands of reddish brown sandy loam. In some places the surface layer is more than 15 percent pebbles and cobbles.

Included with these soils in mapping are some areas of Graycalm, Rubicon, and Nester soils. Graycalm and Rubicon soils are somewhat excessively drained and are more droughty than the Emmet and Montcalm soils. The Nester soils are well drained and are less droughty. The included soils and Emmet and Montcalm soils are in similar positions on the landscape. The included soils make up 10 to 20 percent of the map unit.

Permeability is moderate in the Emmet soil and moderately rapid in the Montcalm soil. The available water capacity of the Emmet soil is moderate, and that of the Montcalm soil is low. Runoff is medium. The surface layer of the Emmet soil is friable and is easily tilled within a wide range of moisture content.

In most areas, these soils are used as cropland or pasture. In a few areas, they are used as woodland or are idle.

These soils are poorly suited to use as cropland; but some crops, such as corn, winter wheat, and oats and grasses and legumes for hay, can be grown. Cover crops, wind stripcropping, windbreaks, and conservation

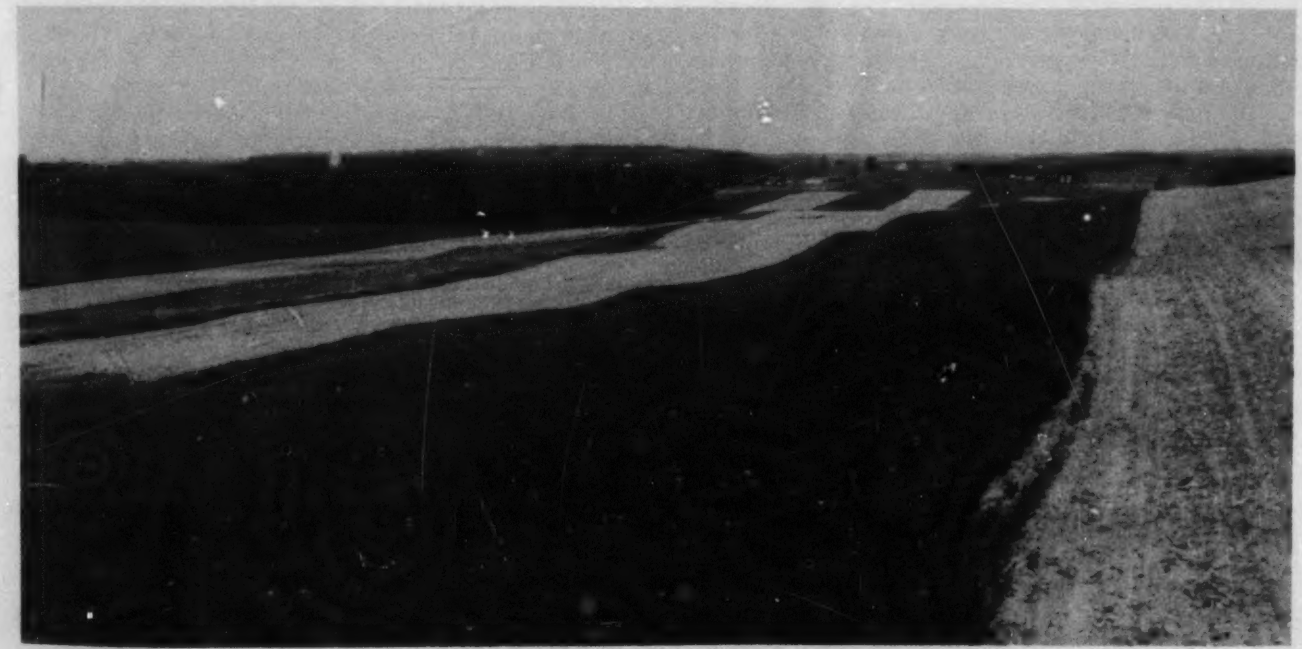


Figure 4.—Stripcropping in an area of Emmet-Montcalm complex, 6 to 12 percent slopes, controls soil blowing and erosion.

tillage that does not invert the soil and that leaves all or part of the crop residue on the surface effectively control soil blowing and erosion (fig. 4). The use of cover crops, green manure crops, crop residue, and manure conserves the available water.

These soils are well suited to pasture. Droughtiness is the main management concern. Proper stocking, rotation grazing or strip grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

The soils are well suited to use as woodland. Seedling mortality is a management concern. Good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations.

The soils are fairly well suited to most recreation uses. Slope is the major limitation. Paths and trails should be placed on the contour. Some shaping or leveling may be needed for camp and picnic areas.

These soils are fairly well suited to use as sites for buildings. Slope is the main limitation. Buildings should be designed to conform to the natural slope. Land shaping may be necessary in some areas.

These soils are fairly well suited to use as septic tank absorption fields. If septic tank absorption systems are to function properly on these soils, land shaping is necessary in most places, and the distribution lines should be installed across the slope.

The land capability classification of these soils is IVe. The Michigan soil management groups are 3a and 4a.

5E—Emmet-Montcalm complex, 12 to 30 percent slopes. This complex consists of rolling to steep, well drained soils on hills and ridges. The areas are irregular in shape and range from about 20 to 300 acres in size.

The Emmet soil makes up about 35 to 40 percent of the complex, and the Montcalm soil makes up about 35 to 40 percent. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

Typically, the Emmet soil has a dark grayish brown, sandy loam surface layer about 6 inches thick. The subsoil is brown, friable and very friable sandy loam about 22 inches thick. The substratum to a depth of 60 inches is pale brown, friable sandy loam. In some places, the surface layer is more than 15 percent pebbles and cobbles.

Typically, the Montcalm soil has a dark grayish brown, loamy sand surface layer about 6 inches thick. The subsoil is about 54 inches thick. The upper part of the subsoil is brown and light yellowish brown, very friable sand. The lower part is light yellowish brown, very friable sand with bands of reddish brown sandy loam. In some places, the surface layer is more than 15 percent pebbles and cobbles.

Included with these soils in mapping are small areas of Graycalm and Rubicon soils. These soils are somewhat excessively drained and are more droughty than Emmet and Montcalm soils. The included soils and the Emmet and Montcalm soils are in similar positions on the landscape. The included soils make up 15 to 25 percent of the map unit.

Permeability is moderate in the Emmet soil and moderately rapid in the Montcalm soil. The available water capacity of the Emmet soil is moderate, and that of the Montcalm soil is low. Runoff is medium.

In most areas, these soils are used as pasture or woodland, or they are idle.

These soils generally are not suited to use as cropland because of the steep slopes and severe erosion hazard. In some areas, the soils were cultivated but are now used as pasture or for Christmas tree plantations.

These soils are poorly suited to pasture, mainly because of erosion and droughtiness. Permanent vegetation helps control erosion on the steeper slopes. It increases or maintains the content of organic matter in the soils, and the organic matter, in turn, increases the available water capacity. Restricting grazing during dry periods helps keep the pasture and soils in good condition.

These soils are well suited to use as woodland. The main concerns in management are the erosion hazard, equipment limitation, and, in some areas, seedling mortality. Logging trails should be constructed on gentle grades to help control erosion and overcome the equipment limitations. Good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations.

The soils are poorly suited to most recreation uses because of the steep slopes. Where possible, paths and trails should be constructed on gentle grades. The steep slopes can prohibit the construction of camp sites and playgrounds or significantly increase the cost.

These soils generally are not suited to building site development or to use as septic tank absorption fields because of the steep slopes. This limitation is extremely difficult to overcome.

The land capability classification of these soils is VIe. The Michigan soil management groups are 3a and 4a.

6B—Kalkaska sand, 0 to 6 percent slopes. This is a nearly level to undulating, somewhat excessively drained soil on upland plains. The areas are irregular in shape and range from about 5 to 800 acres in size.

Typically, the surface layer is black sand and leaf litter about 3 inches thick. The subsurface layer is pinkish gray sand about 3 inches thick. The subsoil is about 34 inches thick. The upper part of the subsoil is dark reddish brown, very friable or loose sand; the middle part is strong brown, loose sand; the lower part is yellowish brown, loose sand. The substratum to a depth of 60 inches is light yellowish brown, loose sand. In some places, the substratum is gravelly sand. In some places, the upper part of the subsoil is not so dark as is typical.

Included with this soil in mapping are small areas of Montcalm and AuGres soils. Montcalm soils are well

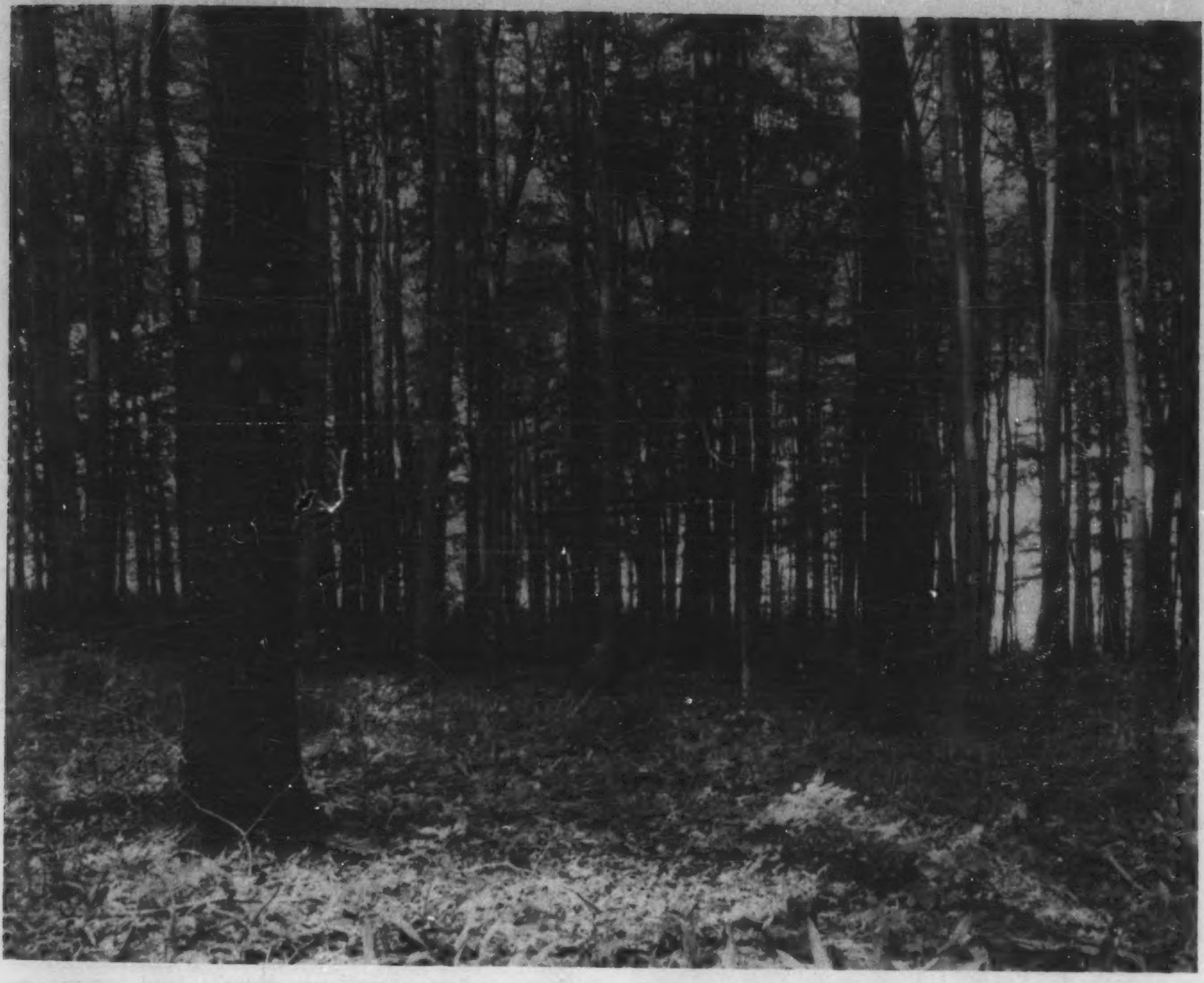


Figure 5.—A stand of sugar maple and beech on Kalkaska sand, 0 to 6 percent slopes.

drained. They are not as droughty as the Kalkaska soil, but they are in similar positions on the landscape. AuGres soils are somewhat poorly drained. They are in shallow depressions. The included soils make up about 10 to 15 percent of the map unit.

Permeability is rapid. The available water capacity is low. Runoff is slow.

Most areas of this soil are wooded. The trees are mainly pine, quaking aspen, northern red oak, and sugar maple (fig. 5). In a few areas, the soil is used as pasture or cropland.

This soil is poorly suited to use as cropland because of droughtiness and soil blowing. Crops, such as corn, oats, and alfalfa and legumes and grasses for hay, can be grown. The use of cover crops, green manure crops, crop residue, and manure helps conserve moisture. Cover crops, wind stripcropping, vegetative barriers, and field windbreaks effectively control soil blowing.

This soil is fairly well suited to use as pasture. The major management concern is droughtiness. Proper stocking, rotation grazing or strip grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

This soil is well suited to use as woodland. Seedling mortality and equipment limitations are the main management concerns. Good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations. The sandy surface layer affects trafficability during dry periods.

This soil is poorly suited to recreation uses. The sandy surface layer is a limitation. Adding a layer of medium textured topsoil can help make a site suitable for playgrounds or camp areas; paths and trails can be covered with wood chips or bark to improve footing.

This soil is well suited to building site development. The limitations are few. The caving of cutbanks is a concern, but trench walls can be reinforced to help prevent cave-ins.

This soil is fairly well suited to use as septic tank absorption fields. The poor filtering capacity is a limitation. This soil can absorb the effluent from septic tanks but cannot adequately filter it. The poor filtering capacity can result in the pollution of ground water.

The land capability classification of the Kalkaska soil is IVs. The Michigan soil management group is 5a.

6C—Kalkaska sand, 6 to 12 percent slopes. This is a gently rolling, somewhat excessively drained soil on ridges, knolls, and side slopes. The areas are irregular in shape and range from 5 to 500 acres in size.

Typically, the surface layer is black sand and leaf litter about 3 inches thick. The subsurface layer is grayish brown sand about 2 inches thick. The subsoil is about 30 inches thick. The upper part of the subsoil is dark reddish brown, very friable or loose sand; the middle part is strong brown, loose sand; and the lower part is yellowish brown, loose sand. The substratum to a depth of 60 inches is light yellowish brown, loose sand. In some places, the upper part of the subsoil is not so dark as is typical.

Included with this soil in mapping are small areas of Montcalm soils. Montcalm soils and the Kalkaska soil are in similar positions on the landscape. Montcalm soils are well drained and are not as droughty as the Kalkaska soil. The included soils make up about 10 percent of the map unit.

Permeability of the Kalkaska soil is rapid. The available water capacity is low. Runoff is slow.

Most areas of this soil are wooded. The trees are mainly pine, American beech, quaking aspen, northern red oak, and sugar maple. In a few areas, the soil is idle.

Because of slope, droughtiness, and soil blowing, this soil generally is not suited to use as cropland and is poorly suited to use as pasture. Pasture yields very little forage for livestock. In some areas, the soil was once cultivated but is now being used for Christmas tree plantations.

The soil is well suited to use as woodland. Seedling mortality and equipment limitations are the main management concerns. Good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations. The sandy surface layer affects trafficability.

This soil is poorly suited to recreation uses. The major management concerns are the sandy surface layer and slope. Adding a layer of medium textured topsoil can help make a site suitable for playgrounds or camp areas; paths and trails can be covered with wood chips or bark to improve footing. To overcome slope limitations, some shaping and leveling may be needed for playgrounds.

This soil is fairly well suited to building site development. Slope is the main limitation. Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas.

The soil is fairly well suited to use as septic tank absorption fields. Slope and the poor filtering capacity of the soil are the main limitations. If septic tank absorption systems are to function properly, land shaping is necessary in most places and distribution lines should be installed across the slope. The Kalkaska soil does not adequately filter effluent. The poor filtering capacity can result in the pollution of ground water.

The land capability classification of the Kalkaska soil is VIs. The Michigan soil management group is 5a.

6E—Kalkaska sand, 12 to 30 percent slopes. This is a rolling to steep, somewhat excessively drained soil on hills and ridgetops. The areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is black sand and leaf litter about 2 inches thick. The subsurface layer is pinkish gray sand about 3 inches thick. The subsoil is about 23 inches thick. The upper part of the subsoil is dark reddish brown, very friable or loose sand; the middle part is strong brown, loose sand; and the lower part is yellowish brown, loose sand. The substratum to a depth of 60 inches is light yellowish brown, loose sand. In some places, the upper part of the subsoil is not so dark as is typical.

Included with this soil in mapping are small areas of landscape. Montcalm soils and Kalkaska soil are in similar positions on the landscape. Montcalm soils are well drained and are not as droughty as the Kalkaska soil. The included soils make up 5 to 10 percent of the map unit.

Permeability of the Kalkaska soil is rapid. The available water capacity is low. Runoff is slow.

Most areas of this soil are wooded. The trees are mainly pine, American beech, quaking aspen, northern red oak, and sugar maple.

Because of the steepness of slope, droughtiness, and soil blowing, this soil generally is not suited to use as

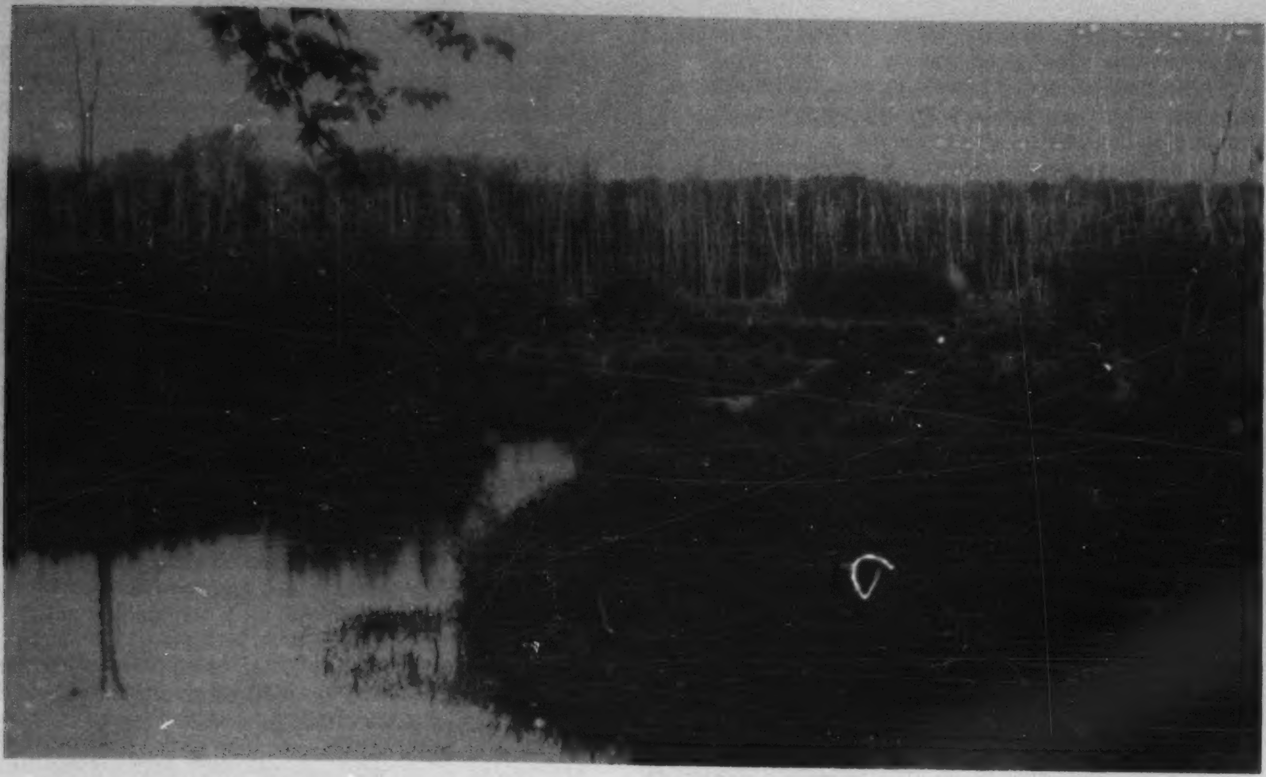


Figure 6.—Lupton muck is mainly along streams and in swamps.

cropland or pasture. Pasture yields very little forage for livestock.

The soil is well suited to use as woodland. The main concerns in management are the erosion hazard, equipment limitations, and seedling mortality. Logging trails should be constructed on gentle grades to help control erosion and overcome the equipment limitations. Good site preparation, the use of containerized seedlings, and replanting of seedlings can reduce seedling mortality in new plantations.

This soil is poorly suited to most recreation uses because of the steep slopes and the sandy surface layer. The steep slopes can prohibit the construction of camp sites and playgrounds or significantly increase construction costs. Adding a layer of medium textured topsoil can help make a site suitable for playgrounds or camp areas, and trails can be covered with wood chips or bark to improve footing.

This soil generally is not suited to building site development or to use as septic tank absorption fields because of the steep slopes. This limitation is extremely difficult to overcome.

The land capability classification of the Kalkaska soil is VIIs. The Michigan soil management group is 5a.

7—Lupton muck. This is a nearly level, very poorly drained soil in depressions, in areas surrounding lakes, and in drainageways (fig. 6). The soil is subject to frequent ponding. The areas are elongated or irregular in shape and range from about 5 to 300 acres in size.

Typically, the surface layer is black muck about 7 inches thick. The underlying layers to a depth of 60 inches are also black muck.

Included with this soil in mapping are small areas of very poorly drained Tawas and Cathro soils. Tawas soils are underlain by sand. Cathro soils are underlain by loamy material. The included soils generally are near the edge of the mapped areas. They make up 5 to 10 percent of the map unit.

Permeability is moderately slow to moderately rapid. The available water capacity is high. Runoff is very slow or ponded. A high water table is at or above the surface from late in fall through spring.

Most areas of this soil are wooded. The trees are mainly northern white-cedar, black spruce, balsam fir, and quaking aspen. In some areas, the soil is covered with shrubs. In a few areas, the soil is in pasture.

Crops generally are not grown on this soil because of wetness and soil instability. In most places, it is not practical to overcome these problems.

This soil is poorly suited to use as pasture, mainly because of wetness and soil instability. Open ditches help remove excess water, but in most places outlets cannot be located.

This soil is poorly suited to use as woodland. The major management concerns are the windthrow hazard and seedling mortality and the limitation on the use of equipment on the soil. Harvesting only during dry periods or when the soil is frozen helps overcome the equipment limitation. Special harvesting methods that do not leave trees widely spaced or standing alone help overcome the windthrow hazard. Because of the high seedling mortality, trees generally are not planted.

This soil is not suited to most recreation uses because of the high water table and the instability of the soil.

This soil is not suited to building site development and to use as septic tank absorption fields because of ponding, the high water table, and the instability of the soil.

The land capability classification of the Lupton soil is Vw. The Michigan soil management group is Mc.

10B—Manistee loamy sand, 0 to 6 percent slopes. This is a nearly level to undulating, well drained soil on broad plains and on low knolls. The areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is dark brown loamy sand about 10 inches thick. The upper part of the subsoil is strong brown, loose sand about 12 inches thick; the next layer is light brownish gray, loose sand about 2 inches thick; the lower part of the subsoil is dark brown, firm clay. The substratum to a depth of 60 inches is brown, firm clay. In some places, there is sandy material in the substratum below a depth of 50 inches. In a few places, the sandy part of the subsoil extends to a depth of more than 40 inches. In some places, the soil is moderately well drained; in other places, the sandy part of the subsoil is underlain by loam or clay loam.

Included in mapping are small areas of Montcalm and Nester soils. Montcalm and Nester soils are well drained. Montcalm soils are more droughty than the Manistee soil, and Nester soils are less droughty. Montcalm and Nester soils and the Manistee soil are in similar positions on the landscape. The included soils make up 5 to 15 percent of the map unit.

Permeability of the Manistee soil is rapid in the upper part of the profile and slow in the lower part. The available water capacity is moderate. Runoff is slow. The surface layer is very friable and is easily tilled within a wide range of moisture content.

This soil is used as cropland or pasture. In a few areas, it is used as woodland.

This soil is fairly well suited to corn and oats and to grasses and legumes for hay. Soil blowing, droughtiness, and organic matter content are the major management concerns. The use of cover crops, green manure crops, crop residue, and manure conserves soil moisture. Wind stripcropping, cover crops, vegetative barriers, grassed waterways, and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help to control soil blowing and erosion.

This soil is well suited to pasture. Droughtiness is the major limitation. Proper stocking, rotation grazing or strip grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

This soil is well suited to use as woodland. Seedling mortality is the main concern in management. Good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations.

This soil is well suited to recreation uses. There are no major management concerns.

The soil is fairly well suited to building site development. It is poorly suited to use as septic tank absorption fields, mainly because of the slow permeability in the lower part of the profile. Constructing larger absorption fields or alternating the drainage fields helps offset the slow permeability. The included areas of Montcalm soil are the best sites for septic tank absorption fields.

The land capability classification of the Manistee soil is IIIs. The Michigan soil management group is 4/2a.

10C—Manistee loamy sand, 6 to 12 percent slopes. This is a gently rolling, well drained soil on ridges, knolls, and side slopes. The areas are irregular in shape and range from about 5 to 80 acres in size.

Typically, the surface layer is dark brown loamy sand about 8 inches thick. The subsoil is about 18 inches thick. The upper part of the subsoil is strong brown, loose sand; the middle part is light brownish gray, loose sand; and the lower part is dark brown, firm clay. The substratum to a depth of 60 inches is brown, firm clay. In some places, the lower part of the subsoil and the substratum are clay loam or loam.

Included with this soil in mapping are small areas of Montcalm and Nester soils. Montcalm and Nester soils are well drained. Montcalm soils are more droughty than the Manistee soil, and Nester soils are less droughty. Montcalm and Nester soils and the Manistee soil are in similar positions on the landscape. The included soils make up 5 to 10 percent of the map unit.

Permeability of the Manistee soil is rapid in the upper part of the profile and slow in the lower part. The available water capacity is moderate. Runoff is medium. The surface layer is very friable and is easily tilled within a wide range of moisture content.

This soil is used mainly as pasture or woodland. In a few areas, it is used as cropland.

The soil is fairly well suited to corn and oats and to grasses and legumes for hay. Erosion, soil blowing, droughtiness, and organic matter content are the major management concerns. Wind stripcropping, cover crops, vegetative barriers, crop residue, grassed waterways, and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help to control soil blowing and erosion. The use of cover crops, green manure crops, crop residue, and manure conserves the available water.

This soil is well suited to pasture. Droughtiness is the major limitation. Proper stocking, rotation grazing or strip grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

This soil is well suited to use as woodland. Seedling mortality is the main concern in management. Good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations.

This soil is fairly well suited to recreation uses. Slope is the major limitation. Some shaping and leveling may be needed for camp and picnic areas and for playgrounds.

This soil is fairly well suited to building site development. Slope is the main limitation. Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas.

This soil is poorly suited to use as septic tank absorption fields, mainly because of the slope and the slow permeability in the lower part of the soil. If septic tank absorption systems are to function properly on this soil, distribution lines should be installed across the slope. Constructing larger absorption fields or alternating the drainage fields help offset the slow permeability. The included areas of Montcalm soils are the best sites for septic tank absorption fields.

The land capability classification of the Manistee soil is IIIe. The Michigan soil management group is 4/2a.

11B—Montcalm-Graycalm complex, 0 to 6 percent slopes. This complex consists of nearly level to undulating soils on upland plains. The Montcalm soil is well drained, and the Graycalm soil is somewhat excessively drained. The areas are irregular in shape and range from about 10 to 800 acres or more in size.

The Montcalm soil makes up about 45 to 70 percent of the complex, and the Graycalm soil makes up about 25 to 40 percent. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

Typically, the Montcalm soil has a surface layer of very dark gray and pinkish gray loamy sand about 7 inches thick. The subsoil is dark brown and yellowish brown, very friable loamy sand about 14 inches thick. The next layer is yellowish brown, very friable loamy sand about 9 inches thick. Between depths of 30 and 60 inches, bands of yellowish brown sand alternate with bands of dark brown sandy loam. In some places, there are a few mottles in the lower part of the subsoil.

Typically, the Graycalm soil has a surface layer of very dark gray sand about 2 inches thick. The subsoil is strong brown and yellowish brown, loose sand about 22 inches thick. The next layer is light yellowish brown, loose sand about 20 inches thick. Below that, alternate bands of light yellowish brown sand and dark brown loamy sand and sandy loam extend to a depth of 60 inches.

Included with these soils in mapping are small areas of Nester, Dighton, Manistee, and Rubicon soils. Nester, Dighton, and Manistee soils are well drained. They are less droughty than the Montcalm and Graycalm soils. Rubicon soils are somewhat excessively drained. They are more droughty. The included soils and the Montcalm and Graycalm soils are in similar positions on the landscape. The included soils make up 5 to 20 percent of the map unit.

Permeability is moderately rapid in the Montcalm soil and rapid in the Graycalm soil. The available water capacity is low. Runoff is slow.

In most areas, the soils are used as cropland, pasture, or woodland (fig. 7).

These soils are fairly well suited to corn and oats and to grasses and legumes for hay. The major management concerns are droughtiness and soil blowing. Early-maturing crops are best suited to these soils. These soils are easily worked, but excessive tillage increases the hazards of soil blowing and erosion. The use of cover crops, green manure crops, crop residue, and manure helps conserve the soil moisture. Cover crops, wind stripcropping, conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface, vegetative barriers, and field windbreaks effectively control soil blowing and erosion.

These soils are fairly well suited to use as pasture. Droughtiness is the major concern. Proper stocking, rotation grazing or strip grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

These soils are well suited to use as woodland. Seedling mortality is the main management concern. Good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations. The sandy surface layer affects trafficability during dry periods.

The soils are fairly well suited to recreation uses. The major limitation is the sandy surface layer. Adding a layer of medium textured topsoil can help make a site suitable for playgrounds or camp areas; paths and trails can be covered with wood chips or bark to improve footing.

These soils are well suited to building site development. The limitations are few. The caving of cutbanks is a concern, but trench walls can be reinforced to help prevent cave-ins.

Figure 7.—Stand of oak and aspen on Montcalm-Graycalm complex, 0 to 6 percent slopes.

The soils are well suited to use as septic tank absorption fields. The poor filtering capacity, however, is a limitation in some areas of the Graycalm soil. This soil can readily absorb the effluent in a septic tank absorption field but cannot adequately filter it. The poor filtering capacity can result in the pollution of ground water.

The land capability classification of these soils is IIIs. The Michigan soil management groups are 4a and 5a.

11C—Montcalm-Graycalm complex, 6 to 12 percent slopes. This complex consists of gently rolling soils on ridges, knolls, and side slopes. The Montcalm soil is well drained, and the Graycalm soil is somewhat excessively drained. The areas are irregular in shape and range from about 5 to 500 acres in size.

The Montcalm soil makes up about 45 to 70 percent of the complex, and the Graycalm soil makes up about 25 to 40 percent. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

Typically, the Montcalm soil has a surface layer of very dark gray and pinkish gray loamy sand about 7 inches thick. The subsoil is dark brown and light yellowish brown, very friable loamy sand about 14 inches thick. The next layer is yellowish brown, very friable loamy sand about 9 inches thick. Between depths of 20 and 60 inches, bands of yellowish brown sand alternate with bands of dark brown sandy loam.

Typically, the Graycalm soil has a surface layer of very dark gray sand about 2 inches thick. The subsoil is strong brown and yellowish brown, loose sand about 22 inches thick. The next layer is light yellowish brown, loose sand about 18 inches thick. Between depths of 42 and 60 inches, bands of light yellowish brown, loose sand alternate with thin bands of dark brown loamy sand and sandy loam.

Included with these soils in mapping are small areas of Nester, Manistee, and Rubicon soils. Nester and Manistee soils are well drained. They are less droughty than Montcalm and Graycalm soils. Rubicon soils are somewhat excessively drained. They are more droughty. The included soils and the Montcalm and Graycalm soils are in similar positions on the landscape. The included soils make up 10 to 20 percent of the map unit.

Permeability is moderately rapid in the Montcalm soil and rapid in the Graycalm soil. The available water capacity is low. Runoff is slow.

In most areas, these soils are used as woodland or pasture. In a few areas, they are used as cropland or are idle.

These soils are poorly suited to use as cropland, but some crops, such as corn and oats and grasses and legumes for hay, can be grown. Droughtiness, soil blowing, and slope are the major concerns in crop management. Deep-rooted crops, such as alfalfa, are more suitable than shallow-rooted crops, which cannot attain optimum growth in dry years. The use of cover crops, green manure crops, crop residue, and manure helps conserve the available water. Cover crops, wind stripcropping, vegetative barriers, field windbreaks, and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface effectively control soil blowing and erosion.

These soils are poorly suited to pasture, mainly because of droughtiness. Permanent vegetation adds organic matter to the soils, and the organic matter, in turn, helps maintain or increase the available water capacity. Proper stocking, rotation grazing or strip grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

The soils are well suited to use as woodland. Seedling mortality is the main management concern. Good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations. The sandy surface layer affects trafficability during dry periods.

The soils are fairly well suited to recreation uses. The major management concern is slope. The sandy surface layer of these soils also is a concern. Paths and trails should be placed on the contour to help overcome the slope limitation. Some shaping and leveling may be needed on sites for camp and picnic areas. Adding a layer of medium textured topsoil can help make a site suitable for playgrounds or camp areas; paths and trails can be covered with wood chips or bark to improve footing.

These soils are fairly well suited to use as sites for buildings. Slope is the main limitation. Buildings should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas.

The soils are fairly well suited to use as septic tank absorption fields. Slope and the poor filtering capacity of the soils are the main limitations. If septic tank absorption systems are to function properly on these soils, land shaping is necessary in most places and the distribution lines should be installed across the slope. The Graycalm soil can readily absorb the effluent in a septic tank absorption field but cannot adequately filter it. The poor filtering capacity can result in the pollution of ground water.

The land capability classification of these soils is IVs. The Michigan soil management groups are 4a and 5a.

11E—Montcalm-Graycalm complex, 12 to 30 percent slopes. This complex consists of rolling to steep soils on hills and ridges. The Montcalm soil is well drained, and the Graycalm soil is somewhat excessively drained. The areas are irregular in shape and range from about 10 to 500 acres or more in size.

The Montcalm soil makes up about 45 to 70 percent of the complex, and the Graycalm soil makes up about 25 to 40 percent. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

Typically, the Montcalm soil has a surface layer of very dark gray and pinkish gray loamy sand about 4 inches thick. The subsoil is dark brown and light yellowish brown, very friable loamy sand about 12 inches thick. Below that, alternate bands of light yellowish brown sand and dark brown sandy loam extend to a depth of 60 inches.

Typically, the Graycalm soil has a very dark gray sand surface layer about 2 inches thick. The subsoil is 20 inches thick. The upper part of the subsoil is strong brown and yellowish brown, loose sand; the next part is light yellowish brown, loose sand; the lower part is light yellowish brown, loose sand. Below that, alternate bands of light yellowish brown sand and dark brown loamy sand and sandy loam extend to a depth of 60 inches.

Included with these soils in mapping are small areas of somewhat excessively drained Rubicon soils. Rubicon soils are more droughty than Montcalm and Graycalm soils. The included soils make up 10 to 20 percent of the map unit.

Permeability is moderately rapid in the Montcalm soil and rapid in the Graycalm soil. The available water capacity is low. Runoff is medium.

In most areas, the soils are used as woodland. The trees are mainly red maple, northern red oak, and red pine. In a few areas, the soils are used as pasture or are idle.

These soils are not suited to use as cropland because of the steep slope, soil blowing, and the low available water capacity.

These soils are poorly suited to pasture, mainly because of soil blowing and droughtiness. Permanent vegetation adds organic matter to the soil, and the organic matter, in turn, helps maintain or increase the available water capacity. Proper stocking, rotation grazing or strip grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

The soils are well suited to use as woodland. The main concerns in management are the erosion hazard, equipment limitations, and seedling mortality. Logging roads should be constructed on gentle grades to help control erosion and overcome the equipment limitations. Good site preparation methods, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations.

These soils are poorly suited to recreation uses. Slope is a major management concern. The steep slopes can limit the construction of camp sites and playgrounds or significantly increase their cost if constructed. The sandy surface layer of the Graycalm soil is an additional concern. Adding a layer of medium textured topsoil can help make a site suitable for playgrounds or camp areas; paths and trails can be covered with wood chips or bark to improve footing.

These soils generally are not suited to building site development because of the steep slopes. They are not suited to use as septic tank absorption fields because of the steep slopes and the poor filtering capacity of the soils. These limitations are extremely difficult to overcome.

The land capability classification of these soils is VIs. The Michigan soil management groups are 4a and 5a.

12B—Nester sandy loam, 1 to 6 percent slopes. This is a nearly level to undulating, well drained soil on broad plains and low knolls. The areas are irregular in shape and range from about 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 9 inches thick. The next layer, about 8 inches thick, is a mixture of grayish brown sandy loam and dark brown clay loam. The subsoil is dark brown, firm clay about 21 inches thick. The substratum to a depth of 60 inches is brown, firm clay loam. In a few places, there is sandy material in the substratum at a depth of more than 40 inches. In some places, the Nester soils are moderately well drained. In some places the subsoil is slightly more than 45 percent clay.

Included with this soil in mapping are small areas of Montcalm, Manistee, and Kawkawlin soils. Montcalm and Manistee soils are well drained. They and the Nester soil are in similar positions on the landscape. The Nester soil is less droughty. Kawkawlin soils are somewhat poorly drained and are in lower positions. The included soils make up 5 to 15 percent of the map unit.

Permeability of the Nester soil is moderately slow. The available water capacity is high. Runoff is slow. The surface layer is friable and is easily tilled within a fairly wide range of moisture content. However, it tends to crust or puddle after hard rains, especially in areas where the plow layer and the subsoil have been mixed.

In most areas, this soil is used as cropland or pasture. In a few areas, it is used as woodland or is idle.

This soil is well suited to corn, winter wheat, and oats and to grasses and legumes for hay. Erosion control and maintaining the content of organic matter and good soil tilth are the major management concerns. Cover crops, crop residue, grassed waterways, and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface help control erosion. The use of green manure crops, crop residue, and manure helps maintain soil tilth. This soil warms up slowly in the spring. Working the soil when it is too wet causes machinery to bog down and also causes puddling and crusting of the surface layer. Plowing the soil at the right content of moisture keeps puddling and crusting to a minimum and helps maintain good tilth.

This soil is well suited to pasture. Overgrazing causes surface compaction, excessive runoff, and erosion. Proper stocking, rotation grazing or strip grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is well suited to use as woodland. There are no major management concerns for this use.

This soil is fairly well suited to building site development. The shrink-swell potential is the major limitation. The shrinking and swelling of the soil can be controlled by widening and backfilling the foundation trench with suitable coarse material and by providing drainage around the buildings.

This soil is poorly suited to use as septic tank absorption fields because of the moderately slow permeability. Enlarging the absorption fields or alternating the drainage fields helps offset the permeability limitation. The included areas of Montcalm soils are the best sites for septic tank absorption fields.

The land capability classification of the Nester soil is IIe. The Michigan soil management group is 1.5a.

12C—Nester sandy loam, 6 to 12 percent slopes. This is a gently rolling, well drained soil on ridges, knolls, and side slopes. The areas are irregular in shape and range from about 5 to 80 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 6 inches thick. The next layer is a mixture of grayish brown sandy loam and dark brown clay loam about 8 inches thick. The subsoil is dark brown, firm clay about 21 inches thick. The substratum to a depth of 60 inches is brown, firm clay loam. In some places this soil is eroded, and the upper part of the subsoil has been mixed into the surface layer in plowing. In these areas, the surface layer is dark yellowish brown or brown clay loam. In some places, the subsoil is slightly more than 45 percent clay.

Included with this soil in mapping are small areas of Montcalm and Manistee soils. They and the Nester soil are well drained and are in similar positions on the landscape. Montcalm and Manistee soils, however, are more droughty than the Nester soil. Also included are Kawkawlin soils in lower areas and in drainageways; these soils are somewhat poorly drained. The included soils make up 5 to 10 percent of the map unit.

Permeability of the Nester soil is moderately slow. The available water capacity is high. Runoff is medium. The surface layer is friable and is easily tilled within a fairly wide range of moisture content. However, it tends to crust or puddle after hard rains, especially in areas where the plow layer and the subsoil have been mixed.

In most areas, this soil is used as cropland or pasture. In a few areas, it is used as woodland or is idle.

This soil is fairly well suited to corn, winter wheat, and oats and to grasses and legumes for hay. Erosion control and maintaining the content of organic matter and good soil tilth are the major management concerns. A crop rotation that includes grasses and legumes helps control erosion. Cover crops, crop residue, grassed waterways, and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface also help control erosion. Runoff is less and erosion is not so great a hazard in areas of close-growing crops. This soil tends to warm up slowly in the spring. Working the soil when it is too wet causes machinery to bog down and also causes puddling and crusting of the surface layer. Plowing the soil at the right content of moisture keeps puddling and crusting to a minimum and helps maintain good tilth.

This soil is well suited to pasture. Overgrazing causes surface compaction, excessive runoff, and erosion. Proper stocking, rotation grazing or strip grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is well suited to use as woodland. There are no major management concerns for this use.

This soil is fairly well suited to most recreation uses. It generally is not suited to playgrounds. The slope is a major limitation. Some shaping and leveling may be needed for camp and picnic areas.

This soil is fairly well suited to building site development. Slope and the shrink-swell potential are the major limitations. Buildings should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. The shrinking and swelling of the soil can be controlled by widening and backfilling the foundation trench with suitable coarse material and by providing drainage around the buildings.

This soil is poorly suited to use as septic tank absorption fields because of the moderately slow permeability. Enlarging the absorption fields or alternating the drainage fields helps offset the permeability limitation. The included areas of Montcalm soils are the best sites for septic tank absorption fields.

The land capability classification of the Nester soil is IIIe. The Michigan soil management group is 1.5a.

13B—Rubicon sand, 0 to 6 percent slopes. This is a nearly level to undulating, somewhat excessively drained soil on uplands. The areas of this soil are irregular in shape and range from about 5 to 1,000 acres or more in size.

Typically, the surface layer is very dark gray sand about 2 inches thick. The next layer is grayish brown sand about 3 inches thick. The subsoil is reddish brown and yellowish brown, loose sand about 19 inches thick. The substratum to a depth of 60 inches is light yellowish brown, loose sand. In some places, there are a few mottles in the lower part of the subsoil and in the substratum. In a few places, strata of gravelly sand are below a depth of 40 inches.

Included with this soil in mapping are small areas of Croswell and AuGres soils. Croswell soils are moderately well drained. They are in low depressions. AuGres soils are somewhat poorly drained. They also are in low de-

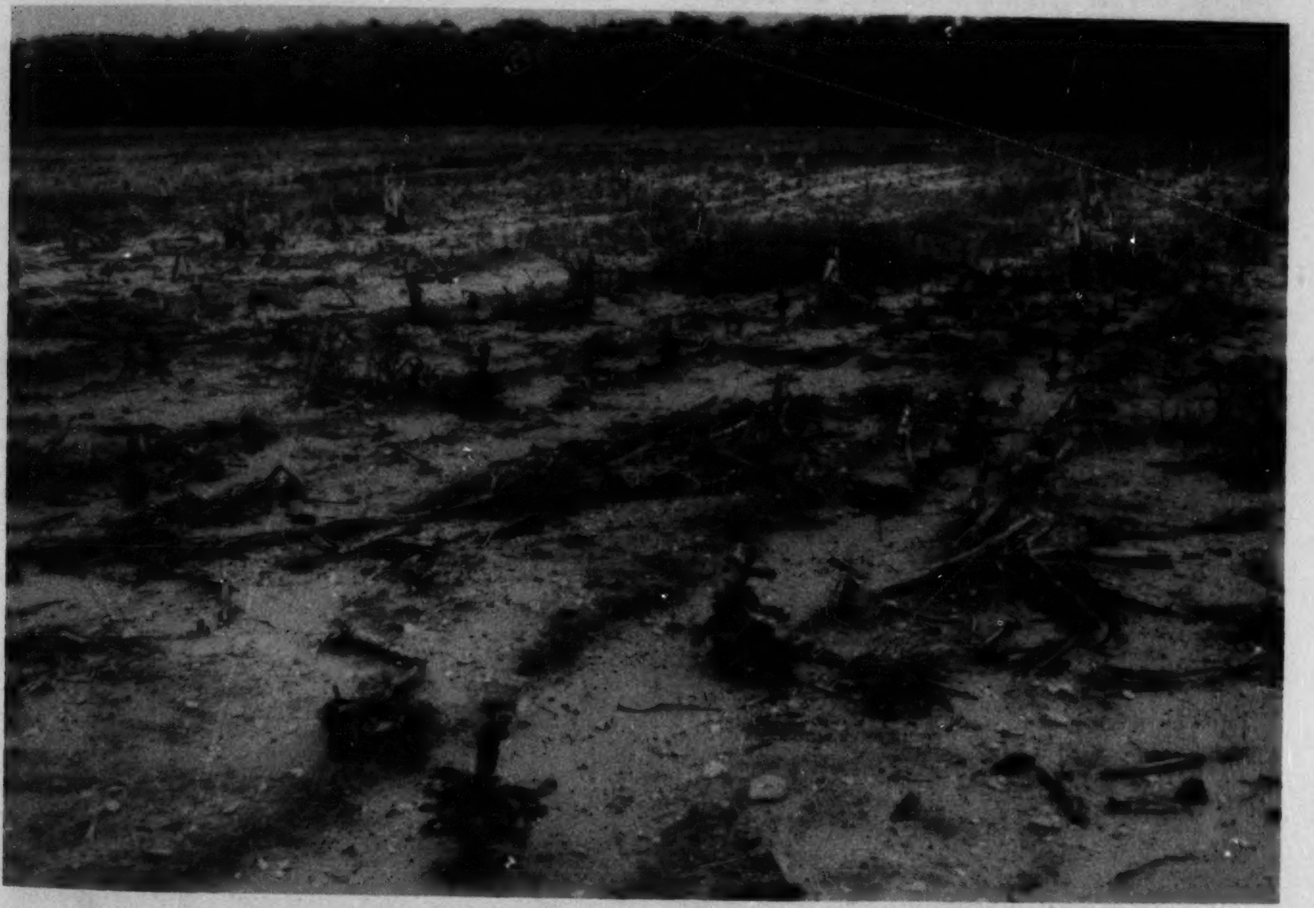


Figure 6.—This area of Rubicon sand, 0 to 6 percent slopes, is being converted from cropland to woodland.

pressions. These soils make up 5 to 10 percent of the map unit.

Permeability of the Rubicon soil is rapid. The available water capacity is low. Runoff is slow.

Most areas of this soil are wooded. The trees are mainly red pine, white pine, bigtooth aspen, red maple, and northern red oak. In a few areas, the soil is used as pasture or cropland.

This soil generally is not suited to use as cropland because of droughtiness and soil blowing. In many areas, the soil was once cultivated but is now used for Christmas tree plantations (fig. 8).

This soil is poorly suited to pasture mainly because of droughtiness. Proper stocking, rotation grazing or strip grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

This soil is fairly well suited to use as woodland. The main management concerns are the high seedling mortality and the limitations on the use of equipment on the soil. Good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations (fig. 9). The sandy surface layer can affect the use of equipment during dry periods.

This soil is poorly suited to recreational uses. The sandy surface layer is a limitation. However, a layer of medium textured topsoil can make a site suitable for playgrounds or camping, and paths and trails can be covered with wood chips to improve footing.

This soil is well suited to building site development. The limitations are few. Caving of cutbanks is a problem, but trench walls can be reinforced to help prevent cave-in. This soil is well suited to use as septic tank absorption fields. The poor filtering capacity, however, is a limitation. This soil can readily absorb the effluent in a septic tank absorption field but cannot adequately filter it. The poor filtering capacity can result in the pollution of ground water.

The land capability classification of the Rubicon soil is VIs. The Michigan soil management group is 5.3a.

13C—Rubicon sand, 6 to 12 percent slopes. This is a gently rolling, somewhat excessively drained soil on ridges, knolls, and side slopes. The areas are irregular in shape and range from about 5 to 1,000 acres or more in size.

Typically, the surface layer is very dark gray and grayish brown sand about 5 inches thick. The subsoil is

Figure 9.—Young red pine plantation on Rubicon sand, 0 to 6 percent slopes.

reddish brown and yellowish brown loose sand about 19 inches thick. The substratum to a depth of 60 inches is light yellowish brown, loose sand. In a few places, strata of gravelly sand are below a depth of 40 inches.

Permeability of the Rubicon soil is rapid. The available water capacity is low. Runoff is slow.

Most areas of this soil are wooded. The trees are mainly red pine, white pine, bigtooth aspen, red maple, and northern red oak.

This soil generally is not suited to use as cropland or pasture because of droughtiness, slope, and soil blowing. Pasture yields very little forage for livestock.

This soil is fairly well suited to use as woodland. Seedling mortality and equipment limitations are the main management concerns. Good site preparation, the use of containerized seedlings, and replanting of seedlings can reduce seedling mortality in new plantations. The sandy surface layer affects trafficability during dry periods.

This soil is poorly suited to most recreation uses, especially for playgrounds. The major management concerns are the sandy surface layer and the slope. Adding a layer of medium textured topsoil can help make a site suitable for playgrounds or camp areas; paths and trails can be covered with wood chips or bark to improve footing. The slope limitation for use of the soil for playgrounds can be overcome by some shaping and leveling.

This soil is fairly well suited to building site development. The slope is a limitation. Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas.

The soil is fairly well suited to use as septic tank absorption fields. Slope and the poor filtering capacity of the soil are concerns in management. If septic tank absorption systems are to function properly on this soil, land shaping generally is necessary and distribution lines should be installed across the slope. This soil can readily absorb the effluent from septic tanks but cannot adequately filter it. The poor filtering capacity can result in the pollution of ground water.

The land capability classification of the Rubicon soil is VIs. The Michigan soil management group is 5.3a.

13E—Rubicon sand, 12 to 30 percent slopes. This is a rolling to steep, somewhat excessively drained soil on hills and ridges. The areas are irregular in shape and range from about 10 to 500 acres in size.

Typically, the surface layer is very dark gray and grayish brown sand about 21 inches thick. The subsoil is reddish brown and yellowish brown, loose sand about 17 inches thick. The substratum to a depth of 60 inches is light yellowish brown, loose sand. In a few places, strata of gravelly sand are below a depth of 40 inches.

Permeability of the Rubicon soil is rapid. The available water capacity is low. Runoff is slow.

Most areas of this soil are wooded. The trees are mainly red pine, white pine, bigtooth aspen, red maple, and northern red oak.

This soil is not suited to use as cropland or pasture because of the steepness of slope, droughtiness, and soil blowing. Pasture yields very little forage for livestock.

This soil is fairly well suited to use as woodland. The erosion hazard, equipment limitations, and seedling mortality are concerns in management. Logging trails should be constructed on gentle grades to control erosion and to overcome the equipment limitations. Good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations.

This soil is poorly suited to recreation uses because of the slope and the sandy surface layer. The steep slopes can prohibit the construction of camp sites and playgrounds or significantly increase construction costs. Adding a layer of medium textured topsoil can help make a site suitable for playgrounds or camp areas; trails can be covered with wood chips or bark to improve footing.

This soil generally is not suited to building site development or to use as septic tank absorption fields. The slope is a severe limitation that is extremely difficult to overcome.

The land capability classification of the Rubicon soil is VIIs. The Michigan soil management group is 5.3a.

14A—Otisco loamy sand, 0 to 3 percent slopes. This is a nearly level, somewhat poorly drained soil on low broad plains, in depressions, and adjacent to streams and drainageways. The areas are irregular in shape and range from 5 to 300 acres in size.

Typically, the surface layer is black loamy sand about 3 inches thick. The subsurface layer is grayish brown loamy sand about 5 inches thick. The mottled subsoil is about 47 inches thick. The upper part of the subsoil is dark brown, very friable loamy sand. The lower part of the subsoil is light yellowish brown, loose sand and has bands of yellowish brown, friable sandy loam. The substratum to a depth of 60 inches is mottled, yellowish brown, loose sand.

Included with this soil in mapping are small areas of Iosco and Roscommon soils. Iosco soils and the Otisco soil are somewhat poorly drained and are in similar positions on the landscape. Iosco soils, however, have a less permeable substratum. Roscommon soils are poorly drained and very poorly drained. They are in wet depressions. The included soils make up 10 to 15 percent of the map unit.

Permeability is moderately rapid or rapid. The available water capacity is low. Runoff is slow. The seasonal high water table is at a depth of 6 to 18 inches from late in fall through early spring.

In most areas, this soil is used as woodland or is idle. In a few areas, it is used as cropland or pasture.

This soil is fairly well suited to crops such as corn, oats, and alfalfa and to legumes and grasses for hay. The main management concern is wetness during part of the growing season. Artificial drainage, by using tile and open ditches, can lower the seasonal high water table. However, locating drainage outlets is difficult in most areas. This soil is often droughty and is subject to soil blowing during the summer. Conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface helps to conserve the available water and reduces erosion. Green manure crops, crop rotation that includes grasses and legumes, and regularly adding other organic matter help maintain or increase the content of organic matter in the soil.

This soil is well suited to use as pasture, but it may lack sufficient moisture during the summer. Proper stocking, rotation grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

This soil is fairly well suited to use as woodland. The main management concerns are seedling mortality and the limitations on the use of equipment. Replanting with seedlings that are suited to the soil reduces seedling mortality. Special site preparation, such as plowing furrows in the fall and planting on the furrow ridges in the spring, can also reduce seedling mortality. The seasonal high water table affects trafficability during wet periods. Limitations on the use of equipment can be overcome by harvesting during dry periods or when the soil is frozen.

This soil is poorly suited to most recreation uses. The seasonal high water table is a limitation. Subsurface drains and shallow open ditches can help lower the water table; however, drainage outlets can be difficult to locate.

This soil is poorly suited to building site development because of wetness. Artificial drainage, by using surface or subsurface methods, helps to lower the water table. Buildings can be placed on well-compacted fill material to raise the level of the site.

The soil also is poorly suited to use as septic tank absorption fields because of wetness. Special construction, such as filling or mounding absorption field sites with suitable material, may be needed to raise the site above the water table for sewage disposal.

The land capability classification of the Otisco soil is IIIw. The Michigan soil management group is 4b.

15B—East Lake-Rubicon sands, 0 to 6 percent slopes. This complex consists of nearly level to undulating, somewhat excessively drained soils on upland plains. The areas are irregular in shape and range from about 5 to 100 acres in size.

The East Lake soil makes up about 50 to 60 percent of the complex, and the Rubicon soil makes up 30 to 40 percent. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

Typically, the East Lake soil has a surface layer of very dark gray and grayish brown sand about 4 inches thick. The subsoil is multicolored, loose sand about 24 inches thick. The substratum to a depth of 60 inches is yellowish brown gravelly sand. In some places, a thin layer of gravelly sandy loam is above the gravelly sand substratum.

Typically, the Rubicon soil has a surface layer of very dark gray and grayish brown sand about 5 inches thick. The subsoil is reddish brown and yellowish brown, loose sand about 19 inches thick. The substratum to a depth of 60 inches is light yellowish brown, loose sand.

Included with these soils in mapping are small areas of Gladwin soils. These soils are somewhat poorly drained. They are in shallow depressions and drainageways. The included soils make up less than 5 percent of the map unit.

Permeability of East Lake and Rubicon soils is rapid. The available water capacity is very low for the East Lake soil and low for the Rubicon soil. Runoff is slow.

In most areas, these soils are used as woodland or are idle. In a few areas, they are used as pasture or cropland.

These soils are poorly suited to use as cropland because of droughtiness. Crops such as corn, oats, and alfalfa can be grown. The use of cover crops, green manure crops, crop residue, and manure conserves soil moisture. Cover crops, wind stripcropping, vegetative barriers, and field windbreaks effectively control soil blowing.

The soils are poorly suited to pasture. The major management concern is droughtiness. Proper stocking, rotation grazing or strip grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

These soils are fairly well suited to use as woodland. Seedling mortality and equipment limitations are the major management concerns. Good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality in new plantations. The sandy surface layer affects trafficability during dry periods.

These soils are poorly suited to recreation uses. The sandy surface layer is a limitation. Adding a layer of medium textured topsoil can help make a site suitable for playgrounds and for picnic and camp areas; paths and trails can be covered with wood chips or bark to improve footing.

These soils are well suited to building site development. The limitations are few. The caving of cutbanks is a concern, but trench walls can be reinforced to help prevent cave-ins.

The soils are well suited to septic tank absorption fields. The poor filtering capacity, however, is a limitation. These soils can readily absorb the effluent from septic tanks but cannot adequately filter it. The poor filtering capacity can result in the pollution of ground water.

The land capability classification of these soils is IVs. The Michigan soil management groups are 5a and 5.3a.

15C—East Lake-Rubicon sands, 6 to 12 percent slopes. This complex consists of gently rolling, somewhat excessively drained soils on ridges, knolls, and side slopes. The areas are irregular in shape and range from about 5 to 60 acres in size.

The East Lake soil makes up about 50 to 60 percent of the complex, and the Rubicon soil makes up 30 to 40 percent. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

Typically, the East Lake soil has a surface layer of very dark gray and grayish brown sand about 4 inches thick. The subsoil is multicolored, loose sand about 24 inches thick. The substratum to a depth of 60 inches is yellowish brown gravelly sand. In some places, a thin layer of gravelly sandy loam is above the gravelly sand substratum.

Typically, the Rubicon soil has a surface layer of very dark gray and grayish brown sand about 5 inches thick. The subsoil is reddish brown and yellowish brown, loose sand about 19 inches thick. The substratum to a depth of 60 inches is light yellowish brown, loose sand.

Permeability of the East Lake and Rubicon soils is rapid. The available water capacity is very low for the East Lake soil and low for the Rubicon soil. Runoff is slow.

In most areas, these soils are used as woodland. The trees are mainly oaks, aspen, and pine.

These soils generally are not suited to use as cropland, and they are poorly suited to pasture because of droughtiness and slope. Pasture yields very little forage for livestock.

The soils are fairly well suited to use as woodland. Seedling mortality and equipment limitations are the main management concerns. Good site preparation, the use of containerized seedlings, and the replanting of seedlings reduce seedling mortality in new plantations. The sandy surface layer of the soils affects trafficability during dry periods.

These soils are poorly suited to most recreation uses, especially for playgrounds. The major management concerns are the sandy surface layer and the slope. Adding a layer of medium textured topsoil can help make a site suitable for playgrounds and camp areas; paths and trails can be covered with wood chips or bark to improve footing. Some shaping or leveling will be needed for playgrounds.

These soils are fairly well suited to building site development. The slope and caving of cutbanks are limitations, but trench walls can be reinforced to help prevent cave-ins. Buildings constructed on these soils should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas.

These soils are fairly well suited to septic tank absorption fields. If septic tank absorption systems are to function properly on these soils, land shaping generally is necessary and the distribution lines should be installed across the slope. The soils cannot adequately filter the effluent from septic tanks. The poor filtering capacity can result in the pollution of ground water.

The land capability classification of these soils is VIs. The Michigan soil management groups are 5a and 5.3a.

15E—East Lake-Rubicon sands, 12 to 30 percent slopes. This complex consists of rolling to steep, somewhat excessively drained soils on hills and ridgetops. The areas are irregular in shape and range from about 5 to 40 acres in size.

The East Lake soil makes up about 50 to 60 percent of the complex, and the Rubicon soil makes up 30 to 40 percent. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

Typically, the East Lake soil has a surface layer of very dark gray and grayish brown sand about 4 inches thick. The subsoil is multicolored, loose sand about 24 inches thick. The substratum to a depth of 60 inches is yellowish brown gravelly sand. In some places, there is a thin layer of gravelly sandy loam above the substratum.

Typically, the Rubicon soil has a surface layer of very dark gray sand about 5 inches thick. The subsoil is reddish brown and yellowish brown, loose sand about 19 inches thick. The substratum to a depth of 60 inches is light yellowish brown, loose sand.

Permeability is rapid. The available water capacity of the East Lake soil is very low, and that of the Rubicon soil is low. Runoff is slow.

In most areas, these soils are used as woodland. The trees are mainly maple, oak, aspen, and pine.

The soils generally are not suited to use as cropland or pasture because of droughtiness and slope. Pastures yield very little forage for livestock.

The soils are fairly well suited to use as woodland. Management concerns include the hazard of erosion, equipment limitations, and seedling mortality. Logging roads should be constructed on gentle grades to control erosion and overcome the equipment limitations. Good site preparation, the use of containerized seedlings, and the replanting of seedlings help reduce seedling mortality in new plantations.

These soils are poorly suited to most recreation uses because of the steep slopes and the sandy surface layer. The steep slopes can prohibit the construction of camp sites and playgrounds or significantly increase construction costs. Adding a layer of medium textured topsoil can help make a site suitable for playgrounds or camp areas; paths and trails can be covered with wood chips or bark to improve footing.

These soils generally are not suited to building site development or to use as septic tank absorption fields.

The steep slopes are a severe limitation that is extremely difficult to overcome.

The land capability classification of these soils is VIIs. The Michigan soil management groups are 5a and 5.3a.

16A—AuGres loamy sand, 0 to 3 percent slopes. This is a nearly level, somewhat poorly drained soil in depressions and in areas adjacent to streams and drainageways. The areas of this soil are irregular in shape and range from 5 to 80 acres or more in size.

Typically, the surface layer is very dark gray loamy sand about 7 inches thick. The subsurface layer is pinkish gray loamy sand about 5 inches thick. The subsoil is mottled and is about 31 inches thick. It is dark brown loamy sand in the upper part and yellowish brown sand in the lower part. The substratum to a depth of 60 inches is yellowish brown, mottled, loose sand. In some places, thin layers of sandy loam have accumulated in the subsoil. In other places, there is loamy material in the substratum at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Roscommon soils and some areas of Croswell soils. Roscommon soils are poorly drained. They are in depressions. Croswell soils are moderately well drained. They are on low knolls. The included soils make up 5 to 10 percent of the map unit.

Permeability is rapid. The available water capacity is low. Runoff is slow. The seasonal high water table is at a depth of 6 to 18 inches from late in fall through spring.

In most areas, this soil is used as woodland or is idle. In a few areas, it is used as cropland or pasture.

This soil is poorly suited to use as cropland, but some crops such as corn and oats and legumes and grasses for hay can be grown. The main management concern is wetness during part of the growing season. A tile drainage system and open ditches can lower the seasonal high water table; however, suitable drainage outlets may be difficult to locate. This soil is often droughty and is subject to soil blowing during the summer. Conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface conserves the available water and reduces erosion. Green manure crops, a crop rotation that includes grasses and legumes, and other organic matter regularly added to the soil help maintain or increase the content of organic matter.

This soil is well suited to use as pasture. The soil may lack sufficient moisture during the summer, but proper stocking, rotation grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

This soil is well suited to use as woodland. The main management concerns are seedling mortality and the limitations on the use of equipment. Good site preparation, the use of containerized seedlings, and replanting using seedlings of suitable species can reduce seedling mortality in new plantations. The seasonal high water table affects trafficability during wet periods. Limitations on the use of equipment can be overcome by harvesting during dry periods or when the soil is frozen.

This soil is poorly suited to most recreation uses. The seasonal high water table and the sandy surface layer are limitations. Subsurface drains and shallow open ditches can lower the water table; however, drainage outlets can be difficult to locate. This soil is often droughty and is subject to soil blowing during the summer. Adding a layer of loamy material to the surface and then, where needed, covering the area with wood chips or bark will help to conserve moisture and to improve footing.

This soil is poorly suited to building site development because of wetness and the poor filtering capacity of the soil. A surface or subsurface drainage system can lower the water table. Also, buildings can be constructed on raised, well-compacted fill material. Because they are moderately well drained, Croswell soils, in the small included areas, are the best sites for houses.

The soil is poorly suited to use as septic tank absorption fields because of wetness and the poor filtering capacity of the soil. Special construction, for example, filling or mounding the absorption field site with suitable material, may be necessary to raise the site above the water table.

The land capability classification is IVw. The Michigan soil management group is 5b.

17—Carbondale muck. This is a nearly level, very poorly drained soil in depressions, in areas surrounding lakes, and in drainageways. It is subject to frequent ponding. The areas are irregular in shape or linear and range from about 5 to 100 acres in size.

Typically, the surface layer is black muck about 17 inches thick. The next part is black muck about 30 inches thick. The underlying material to a depth of 60 inches is dark brown mucky peat.

Included with this soil in mapping are small areas of Tawas and Cathro soils. These soils are very poorly drained. Tawas soils are underlain by sand, and Cathro soils are underlain by loamy material. Tawas and Cathro soils generally are near the boundary of the mapped areas. They make up 5 to 10 percent of the map unit.

Permeability of the Carbondale soil is moderately slow to moderately rapid. The available water capacity is high. Runoff is very slow or ponded. This soil has a high water table at or above the surface from late in fall through spring.

Most areas of this soil are wooded or are covered by shrubs. The trees are mainly northern white-cedar, black spruce, tamarack, and balsam fir. In a few areas, the soil is used as pasture.

This soil generally is not suited to use as cropland because of wetness and soil instability. In most places, it is not practical to overcome these problems.

This soil is poorly suited to pasture mainly because of wetness and soil instability. Open drainage ditches help remove excess water. Many areas are difficult to drain because suitable drainage outlets are not available.

This soil is poorly suited to use as woodland. The main concerns in management are equipment limitations, the windthrow hazard, and seedling mortality. Harvesting only during dry periods or when the soil is frozen helps to overcome the equipment limitations. Harvesting methods that do not leave trees widely spaced or standing alone help prevent windthrow. Trees generally are not planted on this soil because of the high seedling mortality.

This soil is not suitable for recreation uses because of the seasonal high water table and the instability of the soil.

The soil is not suited to building site development or to use as septic tank absorption fields. Ponding, the high water table, and the instability of the soil are limitations.

The land capability classification of this soil is Vw. The Michigan soil management group is Mc.

19B—Grayling sand, 0 to 6 percent slopes. This is a nearly level to undulating, excessively drained soil on upland plains. The areas are irregular in shape and range from about 20 to 1,000 acres or more in size.

Typically, the surface layer is black sand about 3 inches thick. The subsoil is about 25 inches thick. The upper part of the subsoil is dark yellowish brown, very friable sand. The lower part is yellowish brown, loose sand. The substratum to a depth of 60 inches is light yellowish brown, loose sand. In some places, the subsoil has a few thin bands of loamy sand.

Included with this soil in mapping are small areas of soils that have slopes of more than 6 percent and small areas of AuGres soils. The AuGres soils are somewhat poorly drained. They are in depressions and drainageways. The included soils make up 5 percent of the map unit.

Permeability of the Grayling soil is rapid. The available water capacity is very low. Runoff is very slow.

Most areas of this soil are wooded. The trees are mainly jack pine and northern pin oak.

This soil generally is not suited to use as cropland or pasture because of droughtiness and soil blowing. Pastures yield very little forage for livestock.

This soil is poorly suited to use as woodland. The main management concerns are the high seedling mortality and the limitations on the use of equipment. Good site preparation, the use of containerized seedlings, and the replanting of seedlings can reduce seedling mortality on new plantations. The sandy surface layer affects trafficability during dry periods.

This soil is poorly suited to recreation uses. The sandy surface layer is a limitation. Adding a layer of medium textured topsoil can make a site suitable for playgrounds, picnic areas, or camp areas; paths and trails can be covered with wood chips or bark to improve footing.

This soil is well suited to building site development. The limitations are few. The caving of cutbanks is a concern, but trench walls can be reinforced to help prevent cave-in.

This soil is well suited to use as septic tank absorption fields. The poor filtering capacity, however, is a limitation. This soil can readily absorb the effluent from septic tanks but cannot adequately filter it. The poor filtering capacity can result in the pollution of ground water.

The land capability classification of the Grayling soil is VIs. The Michigan soil management group is 5.7a.

20—Tawas mucky peat. This is a nearly level, very poorly drained soil in depressions and drainageways. It is subject to frequent ponding. The areas are irregular in shape or linear and range from 5 to 300 acres in size.

Typically, the surface layer is very dark brown mucky peat about 4 inches thick. Below this is about 18 inches of black muck. The substratum extends to a depth of 60 inches. It is grayish brown, loose sand. In some places, the organic material is made up of nonwoody material.

Included with this soil in mapping are small areas of Roscommon soils and Lupton soils. Roscommon soils are poorly drained. They do not have an organic horizon. Lupton soils are very poorly drained, but they are not underlain by sand. The included soils and the Tawas soil are in similar positions on the landscape. The included soils make up 5 to 10 percent of the map unit.

Permeability of the Tawas soil is moderately slow to moderately rapid in the muck layer and rapid in the underlying sand. The available water capacity is high. Runoff is very slow or ponded. This soil has a high water table at or above the surface from late in fall through spring.

Most areas of this soil are wooded or are covered by shrubs or marsh grasses. The trees are mainly northern white-cedar, balsam fir, black ash, and quaking aspen. In a few areas, the soil is used as pasture.

This soil generally is not suited to use as cropland because of wetness and soil instability. Usually, it is not practical to overcome these problems.

This soil is poorly suited to pasture mainly because of wetness and ponding. Open-ditch drainage helps remove excess water. Many areas are difficult to drain because suitable drainage outlets are not available.

This soil is poorly suited to use as woodland. The major concerns in management are the equipment limitations, windthrow hazard, and seedling mortality. Harvesting only during dry periods or when the soil is frozen helps to overcome the equipment limitations. Harvesting methods that do not leave trees widely spaced or standing alone help prevent windthrow. Trees generally are not planted on this soil because of the high seedling mortality.

This soil is not suited to recreation uses because of the seasonal high water table and the instability of the soil.

The soil is not suited to building site development or to use as septic tank absorption fields because of the high water table and the instability of the soil.

The land capability classification of the Tawas soil is VIw. The Michigan soil management group is M/4c.

22—Roscommon mucky sand. This is a nearly level, poorly drained or very poorly drained soil in depressions and drainageways. It is subject to frequent ponding. The areas are elongated or irregular in shape and range from 5 to 500 acres or more in size.

Typically, the surface layer is black mucky sand about 4 inches thick. The underlying material is multicolored, loose sand to a depth of 60 inches. In some places, there are coarse sand and gravelly sand in the substratum.

Included with this soil in mapping are small areas of Tawas, AuGres, and Croswell soils. Tawas soils are very poorly drained. They are in depressions. AuGres soils are somewhat poorly drained. They are on low knolls. Croswell soils are moderately well drained. They also are on low knolls. The included soils make up 10 to 15 percent of the map unit.

Permeability is rapid. The available water capacity is low. Runoff is very slow or ponded. A high water table is at or above the surface from late in fall through spring.

Most areas of this soil are wooded or are covered with shrubs and marsh grass. The trees are mainly white-cedar, quaking aspen, and yellow birch. In a few areas, the soil is used as pasture.

Because of the seasonal high water table and ponding, crops generally are not grown on this soil. In most areas, it is not practical to overcome these problems.

This soil is poorly suited to use as pasture, mainly because of wetness. Open ditches remove excess water, but in many places outlets are difficult to locate. During the summer, this soil may lack sufficient moisture. Drainage could further increase the droughtiness.

This soil is poorly suited to use as woodland. The major management concerns are the windthrow hazard, seedling mortality, and the limitation on the use of equipment. Harvesting methods that do not leave trees widely spaced or standing alone help prevent windthrow. Because of the high seedling mortality, trees generally are not planted. Harvesting only during dry periods or when the soil is frozen helps to overcome the equipment limitations.

This soil is not suited to recreation uses because of its seasonal high water table and ponding.

Because of ponding and the seasonal high water table, this soil is not suited to building site development or to use as septic tank absorption fields.

The land capability classification of the Roscommon soil is VIw. The Michigan soil management group is 5c.

23A—Kawkawlin Variant sandy loam, 0 to 3 percent slopes. This is a nearly level, somewhat poorly drained soil on low plains, in depressions, and adjacent to streams and drainageways. The areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown sandy loam about 8 inches thick. The next layer is about 4 inches thick. It is yellowish brown, mottled, firm clay loam and has tongues of light brownish gray sandy loam. The subsoil is yellowish brown, mottled, firm clay loam about 16 inches thick. The substratum is brown, mottled, firm clay loam underlain by brown, loose sand. The substratum extends to a depth of 60 inches or more.

Included with this soil in mapping are some areas of Kawkawlin soils and small areas of Dighton soils. Kawkawlin soils and the Kawkawlin Variant soil are in similar positions on the landscape and are somewhat poorly drained. Kawkawlin soils, however, do not have a sandy substratum. Dighton soils are in higher positions on the landscape. They are well drained. The included soils make up 5 percent of the map unit.

Permeability of the Kawkawlin Variant soil is moderately slow in the upper part of the profile and rapid in the lower part. The available water capacity is moderate. Runoff is slow. The seasonal high water table is at a depth of 1 to 2 feet from late in fall through spring. The surface layer is friable and is easily tilled. However, it tends to crust or puddle after hard rains or when the soil is wet.

In most areas, this soil is used as cropland or woodland or is idle. In a few areas, it is in pasture.

This soil is well suited to corn, oats, and winter wheat and to grasses and legumes for hay. The main management concerns are wetness during part of the growing season and soil compaction. Also, this soil warms up slowly in the spring. Surface and subsurface drains help to lower the water table. Working this soil when it is too wet causes soil compaction. Additional tillage to break up the surface layer causes compaction in the lower part of the surface layer and in the subsoil. Compacted soil inhibits root development and reduces crop yields. Conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface helps maintain soil tilth. Cover crops, crop residue, and other organic matter regularly added to the soil also help maintain tilth.

This soil is well suited to pasture. Overgrazing or grazing when the soil is too wet causes surface compaction and the destruction of forage plants. Proper stocking, rotation grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is well suited to use as woodland. The wet, sticky soil, however, limits the use of equipment during wet periods. Harvesting only during dry periods or when the soil is frozen helps to overcome this limitation (fig. 10).

This soil is well suited to recreation uses. It is poorly suited to building site development because of wetness. The soil generally is not suited to use as septic tank

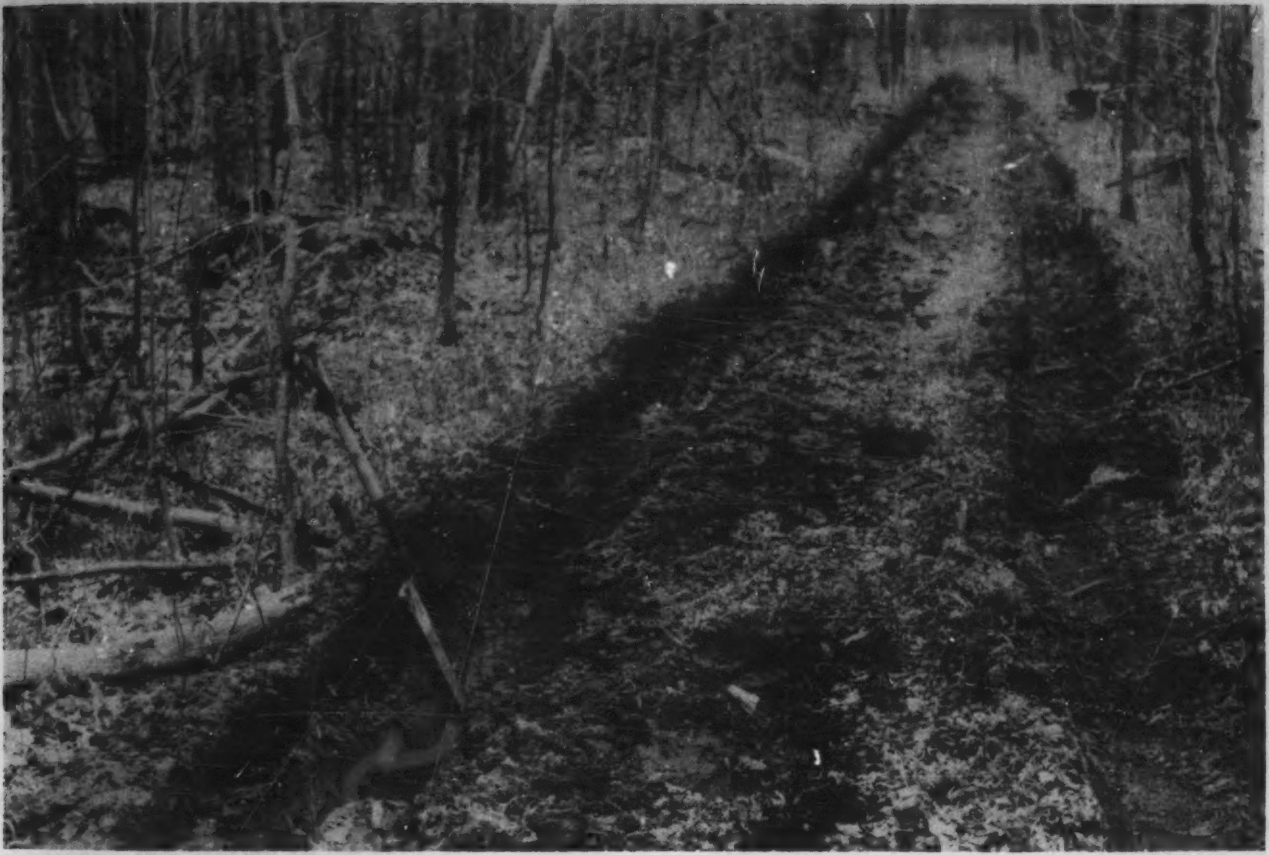


Figure 10.—Deeply rutted logging trail in an area of Kawkawlin Variant sandy loam, 0 to 3 percent slopes. Deep ruts can be prevented by harvesting timber during dry periods.

absorption fields because of wetness, the moderately slow permeability of the upper layers, and the poor filtering capacity of the lower layers.

The land capability classification of this soil is IIw. The Michigan soil management group is 1.5b.

30—Brevort loamy sand. This is a nearly level, poorly drained soil in depressions and drainageways. It is subject to frequent ponding. The areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is black loamy sand about 9 inches thick. The underlying material extends to a depth of 60 inches or more. The upper part of the underlying material is grayish brown, mottled, loose sand about 14 inches thick. The lower part is dark grayish brown, mottled, firm silty clay loam. In some places, the surface layer is more than 10 inches thick. In some places, the surface layer is muck that is less than 16 inches thick.

Included with this soil in mapping are small areas of Sims and Iosco soils. Sims soils are poorly drained. They and the Brevort soil are in similar positions on the landscape. Sims soils are not so droughty in summer as the Brevort soil. Iosco soils are somewhat poorly drained. They are on low knolls. The included soils make up 5 to 10 percent of the map unit.

In the Brevort soil, permeability is rapid or moderately rapid in the sandy material and moderately slow in the loamy material. The available water capacity is moderate. Runoff is very slow or ponded. This soil has a high water table at or above the surface from late in fall through spring.

In most areas, this soil is used as woodland or is idle. In some areas, it is used as cropland or pasture.

This soil generally is not suited to use as cropland. The main concerns in crop management are the seasonal high water table and ponding. The lack of suitable drainage outlets is a problem in most areas. In some areas, tile drains and open ditches are used to lower the water table.

This soil is poorly suited to pasture, mainly because of wetness. Open ditches help remove excess water. Many areas are difficult to drain because suitable outlets are not available. Overgrazing or grazing when the soil is too wet destroys the forage plants. Proper stocking, rotation grazing or strip grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is poorly suited to use as woodland. The main concerns in management are the equipment limitations, the windthrow hazard, and seedling mortality. Harvesting only during dry periods or when the soil is frozen helps to overcome the equipment limitations. Harvesting methods that do not leave trees widely spaced or standing alone help prevent windthrow. Trees generally are not planted because of the high seedling mortality and the windthrow hazard.

This soil is not suited to recreation uses, mainly because of the seasonal high water table and ponding.

This soil is not suited to building site development or to use as septic tank absorption fields because of ponding and the seasonal high water table.

The land capability classification of the Brevort soil is Vw. The Michigan soil management group is 4/2c.

34A—Gladwin loamy sand, 0 to 3 percent slopes. This is a nearly level, somewhat poorly drained soil on low, broad plains and in depressions. The areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black loamy sand about 4 inches thick. The subsurface layer is light brownish gray loamy sand about 3 inches thick. The subsoil is mottled and is about 17 inches thick. The upper part of the subsoil is reddish brown and dark brown, loose sand. The lower part is dark brown, friable gravelly sandy loam. The substratum to a depth of 60 inches is pale brown, loose gravelly sand. In some places, there is loamy material in the substratum at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of East Lake soils, which are somewhat excessively drained. These soils are on low knolls and ridges. They make up less than 5 percent of the map unit.

Permeability is moderately rapid in the upper part of the Gladwin soil and very rapid in the lower part. The available water capacity is low. Runoff is slow. The seasonal high water table is at a depth of 6 to 18 inches from late in fall through spring.

In most areas, the soil is used as pasture or woodland. In a few areas, it is idle.

This soil is fairly well suited to corn and oats and to legumes and grasses for hay. The main management concerns are wetness during part of the growing season, droughtiness, and soil blowing. Tile and open ditch drainage can lower the seasonal high water table. However, many areas are difficult to drain because suitable outlets are not available. Conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface helps conserve the available water in the soil and reduces erosion. The use of green manure crops, crop rotation that includes grasses and legumes, and the regular addition of other organic matter help maintain or increase the organic matter content in the soil.

This soil is well suited to pasture. During the summer, this soil may lack sufficient moisture. Proper stocking, rotation grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

This soil is only fairly well suited to use as woodland. The main management concerns are equipment limitations. The seasonal high water table affects trafficability. Harvesting only during dry periods or when the soil is frozen helps overcome the equipment limitations.

This soil is poorly suited to recreation uses, such as camp areas and playgrounds. It is fairly well suited to picnic areas and trails. The seasonal high water table is a limitation. Subsurface drains and shallow open ditches help lower the water table. However, many areas are difficult to drain because suitable drainage outlets are not available.

This soil is poorly suited to building site development because of wetness. Surface or subsurface drains help lower the water table. Well-compacted fill material should be used to raise the level of the building site. The included areas of East Lake soil are the best sites for single homes.

This soil is poorly suited to use as septic tank absorption fields because of wetness. Special construction, such as filling or mounding the site using suitable material, may be needed to raise the site above the water table.

The land capability classification of the Gladwin soil is IIIw. The Michigan soil management group is 5b.

36B—Dighton sandy loam, 1 to 6 percent slopes. This is a nearly level to undulating, well drained soil on broad plains and low knolls. The areas are irregular in shape and range from about 5 to 30 acres in size.

Typically, the surface layer is dark grayish brown sandy loam about 10 inches thick. The next layer is about 7 inches thick. It is brown, firm clay loam and has tongues of light brownish gray loam. The subsoil is dark brown, firm clay loam about 16 inches thick. The substratum extends to a depth of 60 inches. The upper part of the substratum is brown, firm clay loam. The lower part is light yellowish brown, loose sand and has a few thin bands of brown, friable sandy loam. In some places, the soil is moderately well drained. In some places, the subsoil is slightly more than 45 percent clay.

Included with this soil in mapping are small areas of soils that have slope of more than 6 percent. Also included are small areas of Nester, Manistee, and Montcalm soils. These soils are well drained. Nester soils do not have a sandy substratum. Manistee and Montcalm soils are more droughty than the Dighton soil. The included soils make up 10 to 15 percent of the map unit.

Permeability of the Dighton soil is moderately slow in the upper part of the profile and rapid in the lower part. The available water capacity is moderate. Runoff is medium. The surface layer is friable and is easily tilled within a fairly wide range of moisture content. It tends to crust or puddle after hard rains, especially in areas where the plow layer and the subsoil have been mixed.

In most areas, this soil is used as cropland or pasture. In a few areas, it is used as woodland or is idle.

This soil is well suited to corn, winter wheat, and oats and to grasses and legumes for hay. Erosion, maintaining the content of organic matter, and maintaining good soil tilth are the major management concerns. Cover crops, crop residue, grassed waterways, and conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface helps control erosion. The use of green manure crops, crop residue, and manure maintains soil tilth. This soil warms up slowly in the spring. Working this soil when it is too wet causes machinery to bog down and also causes puddling and crusting of the surface layer. Plowing the soil at the right content of moisture keeps puddling and crusting to a minimum and maintains good tilth.

This soil is well suited to pasture. Overgrazing causes surface compaction, excessive runoff, and erosion. Proper stocking, rotation grazing or strip grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is well suited to use as woodland. There are no major management concerns for this use.

This soil is fairly well suited to building site development. The shrink-swell potential is the major limitation. The shrinking and swelling of the soil can be controlled by widening and backfilling the foundation trench with suitable coarse material and by providing drainage around the buildings.

This soil is poorly suited to use as septic tank absorption fields because of the slow permeability in the upper layers and the poor filtering capacity of the lower layer. The permeability and poor filtering capacity of the soil can be improved by excavating the slowly permeable upper layers and filling with a suitable, more permeable material.

The land capability classification of the Dighton soil is IIe. The Michigan soil management group is 1.5a.

37—Sims loam. This is a nearly level, poorly drained soil in depressions and drainageways. This soil is subject to ponding. The areas are irregular in shape and range from about 5 to 80 acres in size.

Typically, the surface layer is very dark gray loam about 8 inches thick. The subsoil is grayish brown, mottled, firm clay loam about 18 inches thick. The substratum to a depth of 60 inches is grayish brown and yellowish brown, mottled, firm silty clay loam. In some places, there is a muck surface layer that is less than 16 inches thick.

Included with this soil in mapping are small areas of Kawkawlin and Brevort soils. Kawkawlin soils are somewhat poorly drained. They are on low knolls (fig. 11). The Sims soil and Brevort soils are in similar positions on the landscape. Brevort soils are poorly drained. They are more droughty than the Sims soil. The included soils make up 5 to 10 percent of the map unit.

Permeability of the Sims soil is slow. The available water capacity is high. Runoff is very slow or ponded. The soil has a high water table near or above the surface from late in fall through spring.

In most areas, the soil is used as pasture or woodland. In a few areas, it is used as cropland.

This soil generally is not suited to use as cropland because of the seasonal high water table and ponding. Most areas are not drained because suitable drainage outlets are not available.

This soil is poorly suited to pasture. The main management concerns are overgrazing or grazing when the soil is too wet, which causes surface compaction and destroys the forage plants. Proper stocking, rotation grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is poorly suited to use as woodland. The main management concerns are equipment limitations, seedling mortality, and the windthrow hazard. During wet periods, the soil is wet and sticky. Therefore, harvesting should be done only during dry periods or when the soil is frozen. Planting seedlings is difficult most of the time because the soil is too wet. Special site preparation, such as bedding, can be used in some areas. Harvesting methods that do not leave trees widely spaced or standing alone help prevent windthrow.

The soil is not suited to building site development or to use as septic tank absorption fields because of ponding and the seasonal high water table.

The land capability classification of the Sims soil is Vw. The Michigan soil management group is 1.5c.

40A—Iosco loamy sand, 0 to 3 percent slopes. This is a nearly level, somewhat poorly drained soil on low broad plains, in depressions, and along streams and drainageways (fig. 12). The areas are irregular in shape and range from 5 to 300 acres in size.

Typically, the surface layer is dark grayish brown loamy sand about 9 inches thick. The subsurface layer is light brownish gray loamy sand about 2 inches thick. The upper part of the subsoil is dark brown, loose sand about 15 inches thick. The middle part is mottled and mixed dark brown sandy loam and light brownish gray loamy

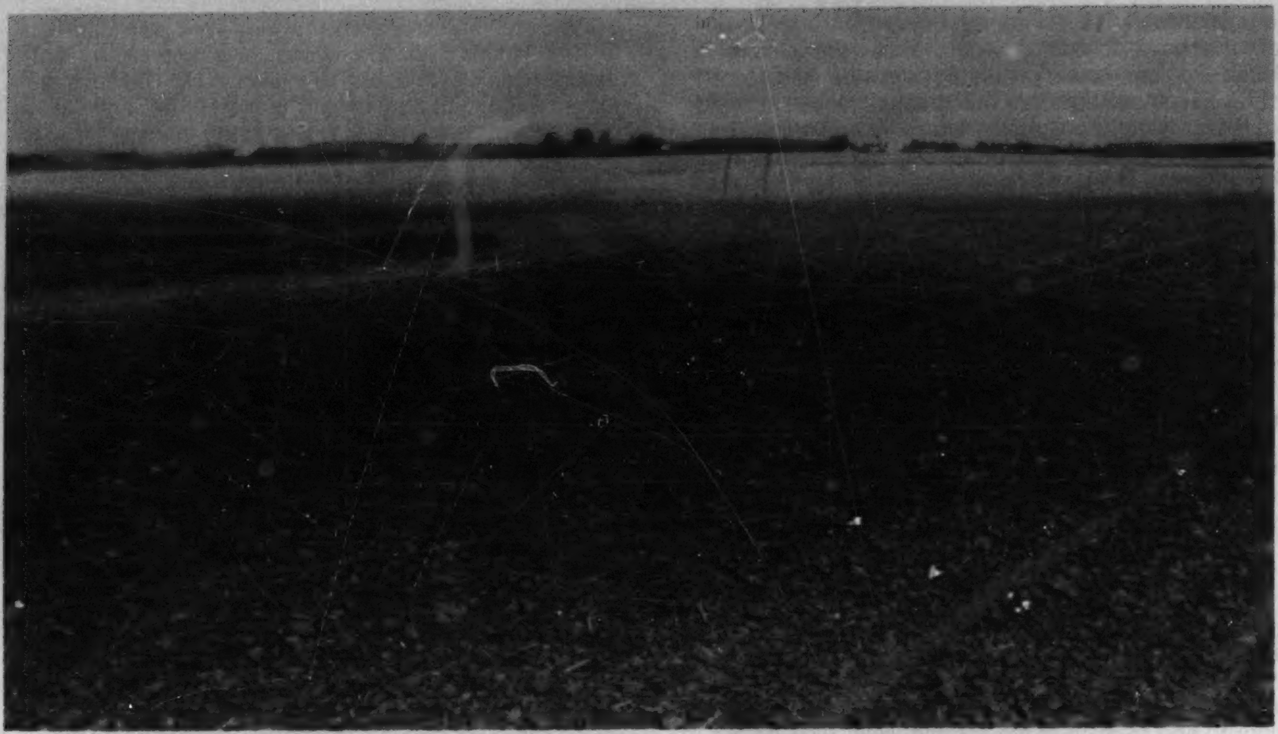


Figure 11.—This area of Sims loam has been prepared for seeding. The contrasting, light-colored soils in the background are Kawkawlin soils.

sand about 5 inches thick. The lower part of the subsoil is dark brown, mottled, firm sandy loam about 15 inches thick. The substratum to a depth of 60 inches is brown, mottled, firm loam.

Included with this soil in mapping are small areas of Kawkawlin, Otisco, and Brevort soils. Kawkawlin and Otisco soils are somewhat poorly drained. They and the Iosco soil are in similar positions on the landscape. Kawkawlin soils are not so droughty as the Iosco soil. Otisco soils do not have a loamy substratum. Brevort soils are poorly drained. They are in shallow depressions. The included soils make up 15 percent of the map unit.

Permeability is rapid in the upper part of the Iosco soil and moderately slow in the lower part. The available water capacity is moderate. Runoff is slow. The seasonal high water table is at a depth of 6 to 18 inches from late in fall through spring.

In most areas, this soil is used as woodland, cropland, or pasture.

This soil is fairly well suited to corn and oats and to legumes and grasses for hay. The main management concerns are wetness during part of the growing season, soil blowing, and maintaining the content of organic matter in the soil. Artificial drainage, using tiles and shallow field ditches, can lower the high water table. However, suitable drainage outlets can be difficult to locate. This soil is often droughty in summer. Conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface helps conserve the available moisture and reduces erosion. Green manure crops, a crop rotation that includes grasses and legumes, and regular additions of other organic matter help maintain or increase the content of organic matter and help conserve moisture.

This soil is well suited to pasture; however, moisture may not be sufficient in summer. Proper stocking, rotation grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

This soil is fairly suited to use as woodland. Equipment limitations are the main management concern. The seasonal high water table affects trafficability during wet periods. Harvesting during dry periods or when the soil is frozen helps overcome this limitation.

This soil is poorly suited to recreation uses such as camp areas and playgrounds. It is fairly suited to picnic areas and paths and trails. The seasonal high water table is a limitation.

This soil is poorly suited to building site development. The major concern is the seasonal high water table. Buildings should be placed on well-compacted fill material to raise the level of the site. Artificial drainage, using surface or subsurface drainage systems, can lower the water table.

This soil also is poorly suited to use as septic tank absorption fields because of the seasonal high water table. Special construction, such as filling or mounding the absorption field site with suitable material, may be needed to raise the site above the water table.

The land capability classification of the Iosco soil is IIIw. The Michigan soil management group is 4/2b.

42B—Graycalm-Rubicon sands, 0 to 6 percent slopes. This complex consists of nearly level to undulating, somewhat excessively drained soils on upland plains. The areas are irregular in shape and range from 10 to 1,000 acres or more in size.

Graycalm sand makes up about 55 to 65 percent of the complex, and Rubicon sand makes up 20 to 30 percent. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

Typically, the Graycalm soil has a very dark gray sand surface layer about 2 inches thick. The subsoil is strong brown and yellowish brown, loose sand about 22 inches thick. The next layer is light yellowish brown, loose sand about 20 inches thick. Below that, alternate bands of light yellowish brown sand and dark brown loamy sand and sandy loam extend to a depth of 60 inches.

Typically, the Rubicon soil has a surface layer of very dark gray sand about 2 inches thick. The next layer is grayish brown sand about 3 inches thick. The subsoil is reddish brown and yellowish brown, loose sand about 19 inches thick. The substratum to a depth of 60 inches is light yellowish brown, loose sand. In a few small areas, there are strata of gravelly sand below a depth of 40 inches. In some places, there are a few mottles in the lower part of the subsoil.

Included with these soils in mapping are small areas of Montcalm soils, which are well drained and have bands in the upper part of the subsoil. They and the Graycalm and Rubicon soils are in similar positions on the land-

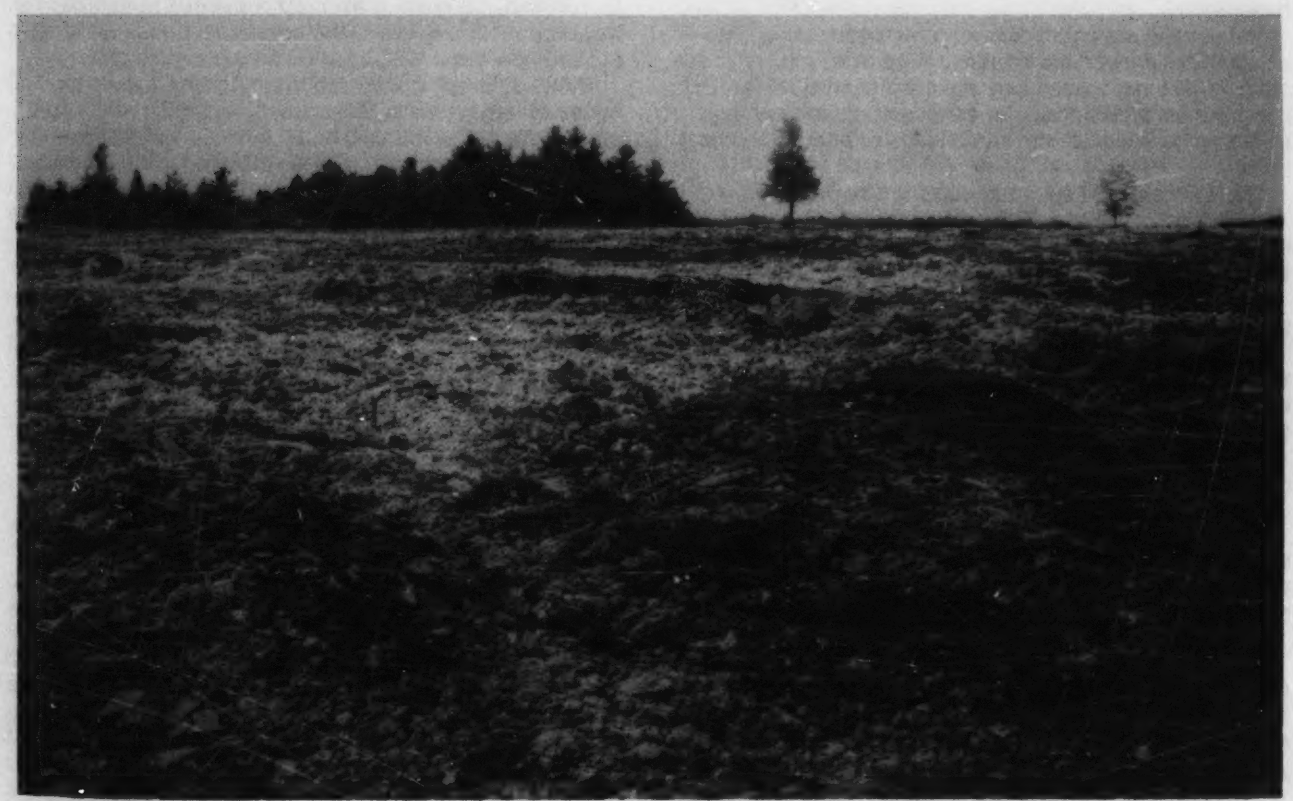


Figure 12.—Plowing has exposed the lighter subsurface layer and the darker (spodic) subsoil of this Iosco loamy sand.

scape. Montcalm soils make up 5 to 15 percent of the map unit.

Permeability of the Graycalm and Rubicon soils is rapid. The available water capacity is low. Runoff is slow.

Most areas of these soils are wooded. The trees are mainly aspen, maple, pine, and oak. In a few areas, the soils are used as pasture or cropland.

These soils are poorly suited to use as cropland because of droughtiness and soil blowing. Crops, such as corn, alfalfa, and oats, can be grown. The use of cover crops, green manure crops, crop residue, and manure helps to conserve soil moisture. Cover crops, wind stripcropping, vegetative barriers, and field windbreaks effectively control soil blowing.

These soils are fairly well suited to pasture. The major management concern is droughtiness. Proper stocking, rotation grazing or strip grazing, and restricted use during dry periods help keep the pasture and soil in good condition.

The soils are well suited to use as woodland. Seedling mortality and equipment limitations are the main management concerns. Good site preparation, the use of containerized seedlings, and the replanting of seedlings reduce seedling mortality in new plantations. The sandy surface layer of the soils affects trafficability during dry periods.

These soils are poorly suited to recreation uses. The sandy surface layer is a limitation. However, a layer of medium textured topsoil can make a site suitable for playgrounds, picnic areas, or camp areas; paths and trails can be covered with wood chips or bark to improve footing.

The soils are well suited to building site development. The limitations are few. The caving of cutbanks is a concern, but trench walls can be reinforced to help prevent cave-in.

These soils are well suited to use as septic tank absorption fields. The poor filtering capacity, however, is a limitation. These soils can readily absorb the effluent in a septic tank absorption field but cannot adequately filter it. The poor filtering capacity can result in the pollution of ground water.

The land capability classification is IVs. The Michigan soil management groups are 5a and 5.3a.

42C—Graycalm-Rubicon sands, 6 to 12 percent slopes. This complex consists of gently rolling, somewhat excessively drained soils on ridges, knolls, and side slopes. The areas are irregular in shape and range from 10 to 500 acres in size.

The Graycalm soil makes up about 55 to 65 percent of the complex, and the Rubicon soil makes up about 20 to 30 percent. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

Typically, the Graycalm soil has a very dark gray sand surface layer about 2 inches thick. The subsoil is strong brown and yellowish brown, loose sand about 22 inches thick. The next layer is light yellowish brown, loose sand about 20 inches thick. Below that, alternate bands of light yellowish brown sand and dark brown loamy sand and sandy loam extend to a depth of 60 inches.

Typically, the Rubicon soil has a surface layer of very dark gray and grayish brown sand about 5 inches thick. The subsoil is reddish brown and yellowish brown, loose sand about 19 inches thick. The substratum to a depth of 60 inches is light yellowish brown, loose sand. In a few small areas, there are strata of gravelly sand below a depth of 40 inches.

Included with this soil in mapping are small areas of Montcalm soils, which are well drained. Montcalm soils are not so droughty as the Graycalm and Rubicon soils. Montcalm soils and the Graycalm and Rubicon soils are in similar positions on the landscape. The Montcalm soils make up 10 to 15 percent of the map unit.

Permeability of the Graycalm and Rubicon soils is rapid. The available water capacity is low. Runoff is slow.

Most areas of these soils are wooded. The trees are mainly aspen, maple, pine, and oak. In some areas, the soils are used as pasture.

The soils generally are not suited to use as cropland because of the slope, droughtiness, and soil blowing. Occasionally, a small grain crop is planted to establish a hay crop. In some areas, the soils were once cultivated but are now used for Christmas tree plantations.

These soils are poorly suited to pasture, mainly because of droughtiness. Permanent vegetation, by adding organic matter to the soil, helps maintain or increase the available water capacity. Proper stocking, rotation grazing or strip grazing, and restricted use during dry periods help keep the pasture in good condition.

These soils are well suited to use as woodland. Seedling mortality and equipment limitations are the main management concerns. Good site preparation, containerized seedlings, and the replanting of seedlings reduce seedling mortality in new plantations. The sandy surface texture of these soils affects trafficability during dry periods.

These soils are poorly suited to most recreation uses, including playgrounds. The main limitations are slope and the sandy surface texture. Some shaping and leveling may be needed for playgrounds. Paths and trails should be constructed on gentle grades. A layer of medium textured topsoil can help make a site suitable for playgrounds and camp areas; paths and trails can be covered with wood chips or bark to improve footing.

These soils are fairly well suited to building site development. Slope and the instability of cutbanks are concerns in management. Buildings on these soils should be designed to conform to the natural slope of the land. Trench walls can be reinforced to help prevent cutbank caving. Land shaping may be necessary in some areas.

These soils are fairly well suited to use as septic tank absorption fields. The main limitations are the slope and the poor filtering capacity of the soils. If septic tank absorption systems are to function properly on these soils, land shaping is necessary in most areas, and distribution lines should be installed across the slope. These soils can readily absorb the effluent from septic tanks but cannot adequately filter it. The poor filtering capacity can result in the pollution of ground water.

The land capability classification of these soils is VIs. The Michigan soil management groups are 5a and 5.3a.

42E—Graycalm-Rubicon sands, 12 to 30 percent slopes. This complex consists of rolling to steep, somewhat excessively drained soils on hills and ridgetops. The areas are irregular in shape and range from 10 to 300 acres or more in size.

The Graycalm soil makes up about 55 to 65 percent of the complex, and the Rubicon soil makes up about 20 to 30 percent. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately at the scale used in mapping.

Typically, the Graycalm soil has a very dark gray sand surface layer about 2 inches thick. The subsoil is strong brown and yellowish brown, loose sand about 22 inches thick. The next layer is light yellowish brown, loose sand about 20 inches thick. Below that, alternate bands of light yellowish brown sand and dark brown loamy sand and sandy loam extend to a depth of 60 inches.

Typically, the Rubicon soil has a surface layer of very dark gray sand underlain by grayish brown sand about 5 inches thick. The subsoil is reddish brown and yellowish brown, loose sand about 19 inches thick. The substratum to a depth of 60 inches is light yellowish brown, loose sand. In a few small areas, there are strata of gravelly sand below a depth of 40 inches.

Included with this soil in mapping are small areas of well drained Montcalm soils. Montcalm soils are not so droughty as the Graycalm and Rubicon soils. Montcalm soils and Graycalm and Rubicon soils are in similar positions on the landscape. The included soils make up 10 to 15 percent of the map unit.

Permeability of the Graycalm and Rubicon soils is rapid. The available water capacity is low. Runoff is medium on the Graycalm soil and slow on the Rubicon soil.

Most areas of these soils are wooded. The trees are mainly aspen, maple, pine, and oak.

Crops and pasture grasses generally are not grown on these soils because of the steep slopes and droughtiness. Pastures yield very little forage for livestock.

These soils are well suited to use as woodland. Erosion is a hazard, however, and equipment limitations and seedling mortality are other management concerns. Logging trails should be constructed on gentle grades to help control erosion and overcome the equipment limitations. Good site preparation, the use of containerized seedlings, and replanting of seedlings can reduce seedling mortality in new plantations.

These soils are poorly suited to most recreation uses because of the steep slopes and the sandy surface layer. The steep slopes can prohibit the construction of camp sites and playgrounds or significantly increase construction costs. A layer of medium textured topsoil can help make a site suitable for playgrounds or camp areas; paths and trails should be covered with wood chips or bark to improve footing.

These soils generally are not suited to building site development or to use as septic tank absorption fields because of the steep slopes. This limitation is extremely difficult to overcome.

The land capability classification is VIIs. The Michigan management groups are 5a and 5.3a.

46—Loxley mucky peat. This is a nearly level, very poorly drained soil in depressions, in areas that surround lakes, and in drainageways. It is subject to frequent ponding. The areas are irregular in shape or linear and range from 5 to 300 acres in size.

Typically, the surface layer is dark brown mucky peat about 5 inches thick. The underlying layers extend to a depth of 60 inches. They are black and dark reddish brown muck.

Included with this soil in mapping are small areas of Tawas soils, which are very poorly drained. Tawas soils are underlain by sand. They generally are near the boundary of the map unit. These soils make up 5 percent of the map unit.

Permeability of the Loxley soil is moderately slow to moderately rapid. The available water capacity is high. Runoff is very slow or ponded. This soil has a high water table near or above the surface from late in fall through spring.

In most areas, this soil is in bogs. The native vegetation is mainly leatherleaf, grasses, sedges, reeds, and mosses. There are a few isolated pines and hardwoods. Wetness and soil instability limit the use of the soil for crops. Also, the soil is too acid for most crops. Usually, it is not practical to overcome these problems. Most areas are not drained. The soil is too unstable to support equipment or livestock.

The soil is not suited to recreation uses. Also, it is not suited to use as septic tank absorption fields. Ponding is the major problem.

The land capability classification of the Loxley soil is VIIw. The Michigan soil management group is Mc-a.

50A—Kawkawlin loam, 0 to 3 percent slopes. This is a nearly level, somewhat poorly drained soil on low, broad plains and in depressions. The areas are irregular in shape and range from 5 to 100 acres or more in size.

Typically, the surface layer is dark grayish brown loam about 8 inches thick. The next layer is mottled and mixed, dark brown clay and grayish brown loam about 4 inches thick. The subsoil is brown, mottled, firm clay loam about 23 inches thick. The substratum to a depth

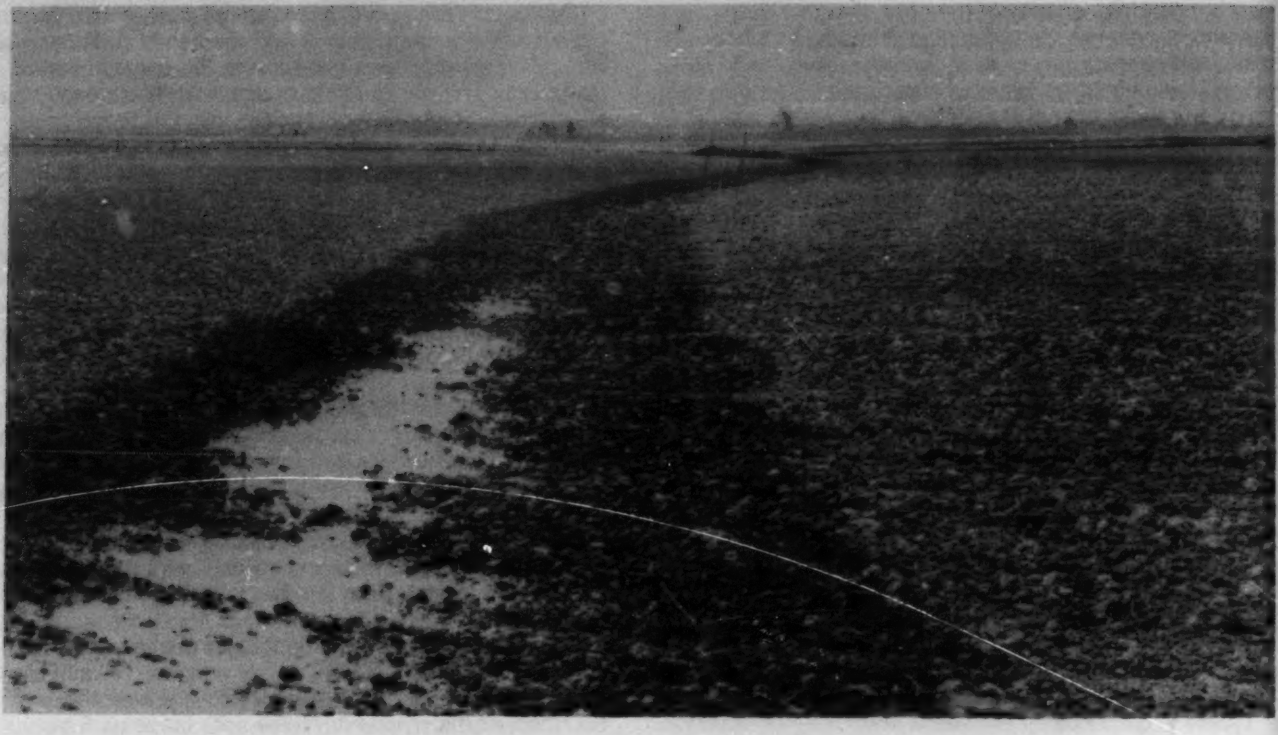


Figure 13.—Surface drainage helps lower the water table in Kawkawlin loam, 0 to 3 percent slopes.

of 60 inches is yellowish brown, mottled, firm clay loam. In some places, the subsoil is slightly more than 45 percent clay.

Included with this soil in mapping are small areas of Iosco and Sims soils. Iosco soils are somewhat poorly drained. They are more droughty than the Kawkawlin soil. Iosco soils and the Kawkawlin soil are in similar positions on the landscape. Sims soils are poorly drained. They are in drainageways and depressions. The included soils make up 10 to 15 percent of the map unit.

Permeability of the Kawkawlin soil is moderately slow. The available water capacity is high. Runoff is slow. The seasonal high water table is at a depth of 12 inches to 24 inches from late in fall through spring. The surface layer is friable and is easily tilled. It tends to crust or puddle after hard rains or when the soil is wet.

In most areas, this soil is used as cropland or pasture. In a few areas, it is used as woodland or is idle.

This soil is well suited to corn, oats, and winter wheat and to grasses and legumes for hay. The main management concerns are wetness during part of the growing season and soil compaction. Also, this soil warms up slowly in spring. Surface and subsurface drains help to lower the water table (fig. 13). Working this soil when it is too wet can result in a compacted soil. Additional tillage to break up the surface layer causes compaction in the lower part of the surface layer and in the subsoil. Compacted soil inhibits root development and reduces crop yields. Conservation tillage that does not invert the soil and that leaves all or part of the crop residue on the surface helps maintain soil tilth. Cover crops, crop residue, and other organic matter regularly added to the soil also help maintain tilth.

This soil is well suited to pasture. Overgrazing or grazing when the soil is too wet causes surface compaction and the destruction of forage plants. Restricted use during wet periods helps keep the pasture and soil in good condition.

This soil is fairly well suited to use as woodland. The wet, sticky soil, however, limits the use of equipment during wet periods. Harvesting only during dry periods or when the soil is frozen helps overcome this limitation.

This soil generally is poorly suited to building site development because of wetness. It generally is not suited to use as septic tank absorption fields because of the wetness of the soil and the slow permeability.

The land capability classification of the Kawkawlin soil is IIw. The Michigan soil management group is 1.5b.

53—Cathro muck. This is a nearly level, very poorly drained soil in depressions and drainageways. It is subject to frequent ponding. The areas are irregular in shape or linear and range from about 5 to 40 acres or more in size.

Typically, the surface layer is black muck about 12 inches thick. The next layer is dark brown muck about 12 inches thick. The substratum extends to a depth of 60 inches. The upper part of the substratum is gray, friable sandy loam. The middle part is greenish gray, firm loam. The lower part is gray, firm clay loam.

Included with this soil in mapping are small areas of Sims soils. Sims soils are poorly drained. They are in slightly higher positions on the landscape than the Cathro soil. Sims soils do not have an organic surface layer or subsoil. The included soils make up 5 to 10 percent of the map unit.

Permeability of the Cathro soil is moderately slow to moderately rapid in the organic layers and moderate or moderately slow in the mineral part. The available water capacity is high. Runoff is very slow or ponded. This soil has a high water table near or above the surface from late in fall through spring.

Most areas of this soil are wooded or are covered by shrubs or marsh grasses. The trees are mainly northern white-cedar, black spruce, tamarack, and balsam fir. In a few areas, the soil is used as pasture.

This soil generally is not suited to use as cropland because of wetness and soil instability. Generally, it is not practical to overcome these problems.

This soil is poorly suited to pasture. Wetness and soil instability are the major management concerns. Open ditches help remove excess water, but in many places, suitable outlets are difficult to locate.

This soil is poorly suited to use as woodland. The major concerns in management are the equipment limitations, the windthrow hazard, and seedling mortality. Harvesting only during dry periods or when the soil is frozen helps overcome the equipment limitations. Harvesting methods that do not leave trees widely spaced or standing alone help prevent windthrow. Trees generally are not planted on this soil because of the high seedling mortality.

This soil is not suited to recreation uses. The high water table and the instability of the soil are major problems.

The soil is not suited to building site development or to use as septic tank absorption fields. Ponding, the high water table, and the instability of the soil are the main limitations.

The land capability classification of the Cathro soil is VIIw. The Michigan soil management group is M/4c.

64—Fluvaquents and Histosols, frequently flooded. These are nearly level, poorly drained or very poorly drained soils that formed on narrow stream bottoms. The soils are subject to flooding from nearby streams for brief periods each year. The areas are linear or winding and range from 5 to 100 acres in size.

Fluvaquents are wet, stratified soils that range in texture from sand to silty clay loam.

Histosols are wet muck soils, or they are muck over sandy to loamy material.

Included with these soils in mapping are small areas of Sims and Roscommon soils. These soils are poorly drained. They and the Fluvaquents and Histosols are in similar positions on the landscape. The included soils make up about 10 percent of the map unit.

In most areas, the soils are used as woodland or are idle. In a few areas, they are used as pasture.

These soils generally are not suited to crops or pasture because of excess water, soil instability, and flooding. Generally, it is not practical to overcome these problems.

These soils are poorly suited to use as woodland. The major management concerns are equipment limitations, windthrow hazard, and seedling mortality. In many areas, the soils are too wet for trees but not for shrubs. Harvesting only during dry periods or when the soil is frozen helps overcome the equipment limitations. Harvesting methods that do not leave trees widely spaced or standing alone help prevent windthrow.

These soils are not suited to recreation uses because of the high water table, instability, and flooding.

The soils generally are not suited to building site development or to use as septic tank absorption fields. Flooding, the high water table, and soil instability are the main limitations.

The land capability classification is Vw. The Michigan soil management groups are L4c and M/4c.

65—Pits, sand and gravel. Pits are open excavations from which sand and gravel have been removed. The excavations are enclosed by walls of variable steepness. The exposed material supports few plants. The bottom of the pits generally is dry year-round. The individual areas of pits range from 4 to 40 acres in size.

Included in the mapped areas are small areas of Udipsamments and some areas from which clay has been removed.

Little or no vegetation grows in the pit areas. Onsite investigation is needed to determine suitability of an area for development as habitat for wildlife or for recreation uses.

This map unit was not assigned to interpretive groupings.

66—Udipsamments, nearly level. This map unit consists of soils from which the original surface layer and some of the substratum have been removed. It also consists of soils that have been covered by fill material. The soils are excessively drained to somewhat poorly drained. In most areas, sandy material was removed from ridges or knolls for use elsewhere. Other areas have been filled for use as building sites. These areas were formerly depressions, flat swampy areas, or lakefront areas. The individual mapped areas range from 4 to 40 acres in size.

Soil properties vary greatly in these areas, especially the depth to the water table.

These areas are either idle or are used as building sites. Onsite investigation is necessary to determine suitability for specific uses.

This map unit was not assigned to interpretive groupings.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil economically to produce a sustained high yield of crops. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are wet, more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed at the end of this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Soils that have limitations, such as a seasonal high water table, frequent flooding during the growing season, or inadequate rainfall, qualify for prime farmland only in areas where these limitations have been overcome by such measures as drainage, flood control, or irrigation. The need for these measures is indicated after the map unit name. Onsite evaluation is needed to determine whether or not these limitations have been overcome by corrective measures.

5B	Emmet-Montcalm complex, 0 to 6 percent slopes
12B	Nester sandy loam, 1 to 6 percent slopes
23A	Kawkawlin Variant sandy loam, 0 to 3 percent slopes (where drained)
36B	Dighton sandy loam, 1 to 6 percent slopes
50A	Kawkawlin loam, 0 to 3 percent slopes (where drained)

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where wetness or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Dwight L. Quisenberry, agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

According to the latest estimates of local agricultural agencies, 66,000 acres in Missaukee County was used as cropland and 20,000 acres was used as pasture and hayland (*11*). In addition, 213,000 acres was used as woodland.

The potential of the soils in Missaukee County for increased crop production is fair. Productivity can be increased by utilizing the latest crop production technology on all cropland in the county. The townships of Lake, Richland, Reeder, Riverside, and Clam Union have experienced a rapid loss of agricultural land.

If irrigated, many soils in the county have good potential for increased crop yields. The soils best adapted to irrigation include the Rubicon, Kalkaska, Manistee, Emmet, and Montcalm soils, all of which are well drained. Irrigation not only supplies water and plant nutrients to the soil but also protects crops from frost damage.

Soil drainage is a major problem on much of the cropland in Missaukee County. In some areas, the poorly drained Brevort and Sims soils have been satisfactorily drained for use as cropland. Most of the poorly drained and very poorly drained soils, however, including Roscommon soils and the organic soils, cannot be economically drained. Such soils are in low-lying plains and in depressions where ponding is frequent and suitable drainage outlets are not readily available. These soils are also subject to a low soil temperature, which hinders seed germination and extends periods of frost. The somewhat poorly drained soils—the Iosco, Kawkawlin, AuGres, and Otisco soils—need artificial drainage. If the excess water is not removed from these soils, tillage, seed germination, and plant growth are adversely affected.

Subsurface tile drainage systems generally are used to remove excess water. Tile drains must be spaced properly to allow for the differences in permeability of the soils. In some areas, open ditches are needed as outlets for the tile drains. More deep open ditches are needed to provide outlets for surface and subsurface drainage.

Nester and Dighton soils have good natural drainage. Emmet, Manistee, and Montcalm soils also have good natural drainage, but droughtiness during long dry periods is a problem. Small areas of wet soils, along drainageways and in swales, commonly are used with larger areas of well drained soils. Artificial drainage may be needed in some of the wet areas to prevent delays in field work.

Soil erosion by water is a problem on some of the soils used for crops and pasture in Missaukee County. If the surface soil is lost and the subsoil is mixed into the plow layer, productivity is reduced. The subsoil of Nester soils, for example, has a higher clay content and a lower organic matter content than the original surface soil. With an increase in clay, the plow layer stays wet longer after a rain, thus delaying field operations. The surface layer also tends to be cloddy and makes a poor seedbed. Surface crusting is more common, and plant emergence can be difficult. More power is required to till eroded soils than noneroded soils. In places, the subsoil of Emmet, Montcalm, Manistee, and Iosco soils has lower content of organic matter, a higher sand content, a lower available water capacity, or poorer soil tilth than the original surface soil.

Exposure of the subsoil will increase the hazard of soil blowing. Where there is soil erosion, there is sediment, which enters tile drains, creeks, and streams. The sediment obstructs the flow in tile drains and outlets and reduces the effectiveness of the system. Sediment entering streams and waterways can contain fertilizer and pesticides, which reduce the quality of the water for public and private use.

Conservation tillage, which leaves crop residue on the surface, increases infiltration and reduces the hazards of runoff and erosion. No-till for corn also effectively reduces erosion. No-till cropping requires high levels of management and relies on herbicides and insecticides for weed and pest control. No-till is especially effective in minimizing erosion on the lighter, sloping soils in the county.

Contour tillage and stripcropping also effectively control erosion. Because of the complexity of the slopes, contour tillage is not commonly used in Missaukee County. Contour tillage is most practical on deep, well drained soils that are highly susceptible to erosion.

Grassed waterways are used on both undulating and nearly level soils; they are used on sloping soils to reduce channel erosion. Grassed waterways can be used to stabilize previously eroded areas that have been reshaped and reseeded. Grassed waterways are installed on nearly level soils if a large watershed drains across the land. Subsurface drains generally are installed below the waterway to remove excess water. Drainage benefits vegetative growth and results in dryer soil conditions, which make the operation of machinery easier.

Grade stabilization structures help control erosion where surface water drains into channels. These structures generally are used in conjunction with grassed waterways both at the outlet end and the inlet end. Grade stabilization structures take the water to a lower elevation and at the same time prevent erosion at the sides and bottom of the channels.

Soil blowing is a hazard on many soils in Missaukee County, especially on the unprotected, drained organic soils and on soils that have a sand, loamy sand, or sandy loam surface layer. Using surface mulch to maintain the plant cover, planting small-grain buffer strips, leaving crop residue on the surface, and maintaining a rough surface through tillage are ways to minimize soil blowing on these soils. Vegetative barriers also are effective in reducing soil blowing. Field windbreaks of adapted trees and shrubs planted at right angles to prevailing winds provide long-term protection from erosion.

Soil fertility is naturally low in the sandy soils in the county and medium in most of the loamy soils. The soils that formed on till plains and moraines, for example, Nester, Kawkawlin, Sims, Emmet, Iosco, and Brevort soils, are high in natural fertility. Soil fertility is quite variable because of difference in past land use and management. Most of the soils in the county are medium acid to neutral in the surface layer. Addition of lime and fertilizer to the soils should be based on the results of soil tests, the need of the crop, and the expected level of yields. The Cooperative Extension Service can help determine the kind and amount of fertilizer and lime to apply.

Soil tilth is an important factor in the germination of seeds and in the workability of the soil. Soils that have good tilth require a minimum of working for seed germination and plant growth. Many of the soils that are used for crops in Missaukee County have a sandy loam, loam, or loamy sand surface texture. Soils that have good tilth have good granular structure and contain a moderate to high amount of organic matter. The use of machinery on the soils when they are wet results in soil compaction and surface crusting. Soil compaction and surface crusting reduce water infiltration and increase runoff. Soil compaction and the loss of good granular soil structure cause small individual soil particles to form. These small particles are readily carried away by wind and water. Preparing a good seedbed on severely eroded soils is difficult, mainly because of their low moisture content and the hazard of surface crusting. Fall plowing of these soils is not recommended because of their susceptibility to excessive erosion. Adequate surface and subsurface drainage, timely field operations, and maintaining the level of organic matter content improve soil structure and tilth and reduce soil compaction and erosion.

Corn, oats, and wheat are the primary field crops suited to the soils in Missaukee County. The legumes commonly grown are alfalfa and clover. Grasses grown for hay and pasture are mainly bromegrass and orchardgrass. Rye, barley, buckwheat, and sorghum-sudangrass are not commonly grown. The crops commonly grown in the county have good potential if economic conditions are favorable.

Special crops, such as strawberries, sunflowers, and potatoes, are grown only on a limited acreage in the county. The well drained loamy sand, sandy loam, and loam soils are suited to these crops. The latest information about growing special crops can be obtained at local offices of the Cooperative Extension Service (*4*) and the Soil Conservation Service.

Much of the permanent pasture in the county is on soils on which erosion can be a hazard. Other pasture is on wet soils. Control of erosion is particularly important during seeding operations. The need for lime and fertilizer should be determined by soil tests, and adequate amounts should be applied as required.

Soil compaction, caused by grazing when the soils are wet, results in decreased growth of pasture plants. Proper harvesting methods, such as those used for hay or silage, help increase plant growth and reduce soil compaction.

The productivity of a pasture and its ability to protect the surface of the soil are influenced by the number of livestock the pasture supports, the length of time the livestock graze, and rainfall distribution. Good pasture management includes proper stocking to maintain key forage plants, pasture rotation, deferred grazing, grazing at the proper season, and supplying water at strategic locations for livestock.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. The land capability classification of each map unit also is shown in the table. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops (*9*). Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 6. The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table. Also given at the end of each soil description is a Michigan soil management group (*5*). The soils are assigned to a group according to the need for lime and fertilizer and for artificial drainage and other practices. For soils making up a complex, the management groups are listed in the same order as the series named in the complex.

Woodland Management and Productivity

David Poe, forester, Soil Conservation Service, helped prepare this section.

The major concerns associated with use and management of woodland are discussed in this section. Information is provided about the major kinds of cover and the relationship with the different kinds of soils. Present and potential woodland products are discussed. The woodland suitability groups of soils and the growth and management problems associated with each are also discussed.

All of what is now Missaukee County originally was covered with virgin forests of pine and hardwood timber. The entire area was logged and the slash burned. Many areas were cleared. Most of the present woodland is second-growth timber. Much of the cleared land has been replanted to pines. The present woodland stands do not as yet approach the original virgin timber stands in size or value. Still, the woodland is certainly an important and valuable resource in this area.

At present, there are about 213,000 acres of woodland in Missaukee County. This represents about 59 percent of the county. About 135,000 acres are state forests. Several private companies have large tracts of woodland, but small, individually owned units make up nearly 78,000 acres of private woodland.

Forest Cover Types

There are five major kinds of natural forest cover within the county (*7*). Each is distinctly different. Each has different value and potential for forest use and for producing woodland products. The soils in the areas of the different kinds of forest cover generally are quite different.

Jack Pine Forest Cover Type comprises about 3,000 acres. Jack pine and northern pin oak predominate. Other common associated trees are eastern white pine, red pine, and bigtooth aspen. This cover type mainly is on Grayling soils. These are deep, sandy soils with weak profile development. The more droughty and less fertile soils support only northern pin oak and jack pine. Growth is slow, and reestablishing tree cover in cutover areas is difficult.

Oak-Red Maple Forest Cover Type comprises about 117,000 acres. Northern red oak and red maple predominate. Other associated trees include bigtooth aspen, red pine, eastern white pine, and paper birch. The original virgin forest cover was mainly eastern white pine. It was almost completely removed through logging. Today, white pine makes up only a small part of the forest cover. Red maple identifies this forest cover from transitional areas of the jack pine cover type. This cover type is mainly on Rubicon, Montcalm, and Graycalm soils. These are deep, sandy soils. Montcalm and Graycalm soils have a loamy band in the subsoil. Growth is good on these soils. Young plantations of red pine and eastern white pine are common within areas of this cover type. Christmas tree plantations of mostly Scotch pine are also common.

Sugar Maple-Beech-Yellow Birch Forest Cover Type comprises about 25,000 acres. Sugar maple is the most common tree and is almost always dominant. However, American beech, yellow birch, and red maple are very common. Other common associated trees are black cherry, northern red oak, and quaking aspen. There are varying numbers of American basswood, eastern hemlock, eastern white pine, red pine, bigtooth aspen, and white ash. The virgin forest in this cover type was northern hardwoods. The soils are Dighton, Emmet, Manistee, Montcalm, and Nester soils. These are loamy soils, but there are areas of the more fertile sandy soils. The soils of this cover type are the most productive in the survey area. Growth is good or excellent, and the potential for wood products is high. Christmas tree plantations of mostly Scotch pine are common within areas of this cover type. The acreage of this cover type is relatively small, because the soils are used mainly for more intensive kinds of farming.

Red Maple-Paper Birch-White Spruce-Balsam Fir Cover Type comprises about 28,000 acres. Most stands are a mixture of wetland hardwoods and conifers and include a wide range of tree species. Red maple, paper birch, quaking aspen, white spruce, balsam fir, and eastern hemlock predominate. Other common associated trees are eastern white pine, northern white-cedar, black ash, and balsam poplar. There are also varying numbers of sugar maple and northern red oak. American elm was an important component of this cover type. Almost all of the elms have died from Dutch elm disease. In many areas, much of the deadwood has been removed for firewood. This cover type is on sandy and loamy soils that have a seasonal high water table. The soils are AuGres, Croswell, Iosco, Otisco, and Kawkawlin soils. Tree growth is fair to good on these soils.

Northern White-Cedar Forest Cover Type comprises about 41,000 acres. Northern white-cedar predominates, but other common associated trees are black spruce, black ash, red maple, eastern hemlock, balsam fir, balsam poplar, and tamarack. This cover type is on Lupton, Carbondale, Roscommon, Tawas, and Cathro soils and on Fluvaquents and Histosols. These are poorly drained and very poorly drained organic and sandy mineral soils. The water table is at or near the surface most of the time. Tree growth is slow. Reestablishing stands of desirable trees in cutover areas is difficult. Windthrow is a serious hazard in areas that are opened up by cutting.

Woodland Products

The amount of woodland products harvested each year in the county is steadily increasing, and the potential exists for continuous high production. There is a need, however, for better woodland management, particularly on privately owned land, if this potential is to be realized. Some of the more important woodland products this county produces are:

Christmas trees.— This is one woodland product that has expanded to the limits of current demand. The growing and marketing of Christmas trees is an important industry in the county. Trees are shipped each fall to many parts of the United States. About 80 percent of the Christmas trees are Scotch pine. Spruce makes up most of the remainder. The Scotch pine usually is harvested at an age of 6 to 8 years. Spruce is harvested at an age of 8 to 12 years. Most Christmas trees are grown on deep sandy soils, including Kalkaska, East Lake, Rubicon, Montcalm, Graycalm, Manistee, and Croswell soils (fig. 14).

Pulpwood.— Most of the pulpwood is taken from cuttings in small tracts of state land or from land owned by paper companies. Aspen and jack pine are the most common trees cut for pulp. Some spruce, balsam fir, and hemlock are also cut for pulp. The county has potential for producing a large amount of pulpwood. One reason that little pulpwood is taken from small, privately owned woodland tracts is that individual tracts are too small to justify logging operations. Owners of several adjoining tracts, however, could combine their logging operations.

Lumber.— An increasing amount of timber is being harvested for sawlogs in the county. The trees in most wooded areas are relatively young. Most are pole or sapling size. Most of the large, high quality trees have been removed. Most of the remaining larger trees are of poor quality and cannot be used for lumber. Only an occasional area has many high quality trees of sawlog size. Most northern hardwood stands should be culled or thinned or both. Most pine plantations should also be thinned. Northern red oak, sugar maple, and red pine mainly are cut for lumber. Aspen is cut for pallet material.

Firewood.— Firewood is becoming more important as a source of heat and energy as fossil fuels become more expensive. Many homes use firewood as either the main source or a supplementary source of heat. Wood chips provide a good source of fuel. The entire tree can be utilized for this purpose. Oak and maple are most commonly used for firewood, but most trees have some value as fuel.

Poles and posts.— The numerous red and jack pine plantations that need thinning are a good potential source of treated poles and posts. Northern white-cedar in some of the wet areas is a potential source of posts.

Maple syrup.— Northern hardwood stands that contain mature sugar maple trees have good potential for the production of maple syrup.

Woodland recreation.— With the large amount of woodland in the county, particularly the large amount on public lands, woodland oriented recreation is possible year-round.

The Soil Conservation Service, Michigan Department of Natural Resources, Cooperative Extension Service, or consultant foresters can help determine woodland management needs.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each suitable soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. It is based on the site index of the species listed first in the *common trees* column. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *r* indicates steep slopes; *x*, stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted rooting depth; *c*, clay in the upper part of the soil; *s*, sandy texture; and *f*, high content of coarse fragments in the soil profile. The letter *a* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: r, x, w, t, d, c, s, and f.

Figure 14.—Christmas tree plantation on Montcalm-Graycalm complex, 0 to 6 percent slopes.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that few trees may be blown down by strong winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Recreation is a major land use in Missaukee County. Most of the land in the county is used for nonintensive recreational uses, such as fishing, hunting, camping, hiking, and sightseeing. Winter activities include downhill and cross-country skiing and snowmobiling. About 7,000 acres is used for intensive recreational uses, such as parks, campgrounds, and picnic areas. Because of an expanding population, increasing land prices, and rising agricultural production costs, land use is certain to undergo changes in the future. More land probably will be converted to use for various types of recreation.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Missaukee County has a variety of wildlife and various designated wildlife management areas. The principal wildlife in the county include white-tailed deer, eagles, black bear, gray squirrels, snowshoe hares, bobcats, and various species of birds. The management areas include the Dead Stream Swamp, which is one of the largest swamps in Michigan's Lower Peninsula; courting and nesting areas for the sharp-tailed grouse; a nesting area for the Kirtland warbler; a research station that gathers information about white-tailed deer; and various waterfowl nesting and resting areas.

Many lakes and streams in the county provide good fishing for trout, northern pike, largemouth bass, walleye, and a variety of other game fish.

Habitat for wildlife in Missaukee County ranges from farmland to northern hardwood climax forests. Much of the habitat can be improved by establishing more water areas and by increasing the planting of appropriate vegetation to provide adequate food and cover.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, and oats.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are dandelions, goldenrod, ragweed, lambsquarters, and quackgrass.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, ash, apple, hawthorn, dogwood, maple, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and hemlock.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, arrowhead, wildrice, cattail, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, killdeer, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, owls, raccoon, deer, and bear.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, loons, blackbirds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, and the available water capacity in the upper 40 inches affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, and flooding affect absorption of the effluent. Large stones interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, and soil reaction affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, and rock fragments.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel or stones, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders or organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water. The content of large stones affects the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones. The performance of a system is affected by the depth of the root zone and soil reaction.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, and slope affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 17, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Soil Characterization Data

Many of the soils in Missaukee County were sampled and laboratory data were determined by the Soil Research Laboratory, Ford Forestry Center, Michigan Technological University, L'Anse, Michigan. The laboratory data obtained from the soil samples include particle-size distribution analysis, coarse fragment analysis, bulk density and moisture retention data. Complete chemical analyses were also performed on each sample, and spodic horizon criteria were determined on the appropriate samples. Standard National Cooperative Soil Survey procedures were used for all analyses. In addition to soil samples, forest sites were sampled to estimate forest productivity on many of the sampled soils.

These data were used in the classification and correlation of these soils and in evaluating their behavior, especially under forestry uses. Eight profiles were selected as representative for the respective series. These series and their laboratory identification number are: AuGres (S80MI113-1), Dighton (S80MI113-3), East Lake (S80MI113-5), Grayling (S81MI113-2), Kawkawlin (S80MI113-6), Montcalm (S80MI113-2), Roscommon (S81MI113-1), and Rubicon (S80MI113-4).

In addition to the Missaukee County data, soil characterization data and forest site data are available from nearby counties that have many of the same soils that were not sampled in Missaukee County. These data and the Missaukee County data are available from the Soil Research Laboratory, Ford Forestry Center, Michigan Technological University, L'Anse, Michigan; Soil and Water Conservation Division, Michigan Department of Agriculture, Lansing, Michigan; and Soil Conservation Service, East Lansing, Michigan.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*10*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquents (*Hapl*, meaning minimal horizonation, plus *aquent*, the suborder of the Entisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Mollic* identifies the subgroup that typifies the great group. An example is Mollic Haplaquents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is sandy over loamy, mixed, nonacid, frigid Mollic Haplaquents.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*8*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*10*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

AuGres Series

The AuGres series consists of somewhat poorly drained, rapidly permeable soils on outwash plains and till plains. The soils formed in sandy glacial drift material. The slope ranges from 0 to 3 percent.

These soils are taxadjuncts to the AuGres series because they have more organic carbon in the Bs horizon than that defined as the range for the series. Furthermore, they have less weatherable minerals. These differences, however, do not affect the use or behavior of the soils.

AuGres soils are similar to Croswell, Gladwin, and Otisco soils and commonly are adjacent to Roscommon and Rubicon soils. Croswell soils are moderately well drained. Gladwin and Otisco soils have an argillic horizon. Rubicon soils are somewhat excessively drained. Roscommon soils are poorly drained or very poorly drained and do not have a spodic horizon.

Typical pedon of AuGres loamy sand, 0 to 3 percent slopes, 1,200 feet south and 250 feet east of the center of sec. 10, T. 21 N., R. 8 W.

A—0 to 7 inches; very dark gray (10YR 3/1) loamy sand and grains from the E horizon, gray (10YR 5/1) dry; weak fine granular structure; very friable; many medium and fine roots; very strongly acid; abrupt smooth boundary.

E—7 to 12 inches; pinkish gray (7.5YR 6/2) loamy sand; weak fine granular structure; very friable; many fine roots; very strongly acid; abrupt smooth boundary.

Bs1—12 to 16 inches; dark brown (7.5YR 3/4) loamy sand; few fine faint dark brown (7.5YR 4/4) mottles; weak medium crumb structure; very friable; about 15 to 20 percent weakly cemented dark reddish brown (5YR 3/3) chunks of ortstein; common fine roots; medium acid; abrupt smooth boundary.

Bs2—16 to 21 inches; dark brown (7.5YR 4/4) loamy sand; common medium distinct strong brown (7.5YR 5/6) mottles; weak medium crumb structure; very friable; few fine roots; medium acid; clear smooth boundary.

BC—21 to 43 inches; yellowish brown (10YR 5/6) sand; common medium distinct strong brown (7.5YR 5/6) mottles; single grained; loose; few fine roots; strongly acid; gradual wavy boundary.

C—43 to 60 inches; yellowish brown (10YR 5/4) sand; common medium distinct strong brown (7.5YR 5/6) mottles; single grained; loose; few fine roots; strongly acid.

The solum is 20 to 48 inches thick. It ranges from extremely acid to neutral.

In cultivated areas, an Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 1.

The A horizon has value of 2 or 3. It is dominantly loamy sand, but the range includes sand. In some pedons, there is a Bh horizon that has hue of 7.5YR or 5YR, value of 2 or 3, and chroma of 3. The Bs horizon has hue of 10YR, 7.5YR, or 5YR, value of 3 to 6, and chroma of 4 to 6. The C horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2 to 4.

Brevort Series

The Brevort series consists of poorly drained soils on till plains. The soils formed in coarse textured deposits over moderately fine textured deposits. Permeability is rapid or moderately rapid in the upper part of the pedon and moderately slow in the lower part. The slope ranges from 0 to 2 percent.

Brevort soils commonly are adjacent to Iosco, Kawkawlin, and Sims soils. Iosco and Kawkawlin soils are somewhat poorly drained. Unlike Brevort soils, Kawkawlin and Sims soils are not sand in the upper layers.

Typical pedon of Brevort loamy sand, 900 feet north and 150 feet east of the center of sec. 32, T. 21 N., R. 6 W.

Ap—0 to 9 inches; black (10YR 2/1) loamy sand, gray (10YR 5/1) dry; weak medium granular structure; friable; common fine roots; neutral; abrupt smooth boundary.

Cg1—9 to 23 inches; grayish brown (10YR 5/2) sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; few fine roots; about 5 percent pebbles; mildly alkaline; clear wavy boundary.

2Cg2—23 to 60 inches; dark grayish brown (10YR 4/2) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; firm; few fine roots; strong effervescence; moderately alkaline.

The depth to carbonates and to the 2C horizon ranges from 20 to 30 inches. Pebbles and cobbles range from 0 to 5 percent throughout. Reaction in the Ap and Cg1 horizons ranges from slightly acid to mildly alkaline.

In undisturbed areas, an A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. It is 1 to 4 inches thick.

The Ap horizon has value of 2 or 3, and chroma of 1 or 2. It is 8 to 10 inches thick. The Ap horizon dominantly is loamy sand, but the range includes mucky loamy sand.

The Cg1 horizon has value of 4 to 6 and chroma of 1 or 2. The 2Cg2 horizon has value of 4 or 5 and chroma of 1 to 4. It is silty clay loam or clay loam.

Carbondale Series

The Carbondale series consists of very poorly drained, moderately slowly to moderately rapidly permeable soils in depressions on outwash plains, till plains, and moraines. The soils formed in deep, herbaceous organic deposits. The slope ranges from 0 to 2 percent.

Carbondale soils are similar to the Lupton soils and commonly are adjacent to Cathro and Tawas soils. Cathro and Tawas soils have thinner organic layers than the Carbondale soils. Lupton soils do not have hemic material in the bottom tiers.

Typical pedon of Carbondale muck, 1,200 feet east and 600 feet south of the northwest corner of sec. 19, T. 21 N., R. 7 W.

Oa1—0 to 7 inches; black (10YR 2/1) broken face and rubbed sapric material, very dark grayish brown (10YR 3/2) dry; about 10 percent fiber, less than 5 percent rubbed; weak fine granular structure; very friable; many fine roots; primarily herbaceous fibers; few coarse woody fragments; slightly acid; clear wavy boundary.

Oa2—7 to 24 inches; black (10YR 2/1) broken face and rubbed sapric material; about 20 percent fiber, less than 5 percent rubbed; weak medium granular structure; very friable; few fine roots; primarily herbaceous fibers; few coarse woody fragments; slightly acid; gradual wavy boundary.

Oa3—24 to 37 inches; black (10YR 2/1) broken face and rubbed sapric material; about 35 percent fiber, 10 percent rubbed; massive; very friable; primarily herbaceous fibers; few coarse woody fragments; slightly acid; clear wavy boundary.

Oe—37 to 60 inches; dark brown (7.5YR 3/2) broken face and rubbed hemic material; about 75 percent fiber, 40 percent rubbed; massive; very friable; primarily herbaceous fibers; slightly acid.

The organic layers are 51 inches thick or more. In some pedons, woody fragments are mixed throughout the organic layers. Reaction ranges from strongly acid to neutral.

The surface tier typically is sapric material, but in some pedons, there are hemic materials or both sapric and hemic materials.

Cathro Series

The Cathro series consists of very poorly drained soils in depressions on till plains and moraines. The soils formed in herbaceous material underlain by loamy mineral material at a depth of 16 to 50 inches. Permeability is moderately slow to moderately rapid in the upper part of the pedon and moderate or moderately slow in the lower part. The slope ranges from 0 to 2 percent.

Cathro soils are similar to Tawas soils and commonly are adjacent to Sims soils. Tawas soils are underlain by sandy material at a depth of 16 to 50 inches. Sims soils do not have an organic horizon.

Typical pedon of Cathro muck, 300 feet north and 100 feet east of the southwest corner of sec. 11, T. 22 N., R. 8 W.

Oa1—0 to 12 inches; black (10YR 2/1) broken face and rubbed sapric material, very dark brown (10YR 2/2) dry; about 15 percent fibers, less than 5 percent rubbed; weak fine granular structure; very friable; many medium roots; primarily herbaceous fibers; medium acid; clear smooth boundary.

Oa2—12 to 24 inches; dark brown (7.5YR 3/2) broken face, very dark gray (7.5YR N3/0) rubbed sapric material; about 40 percent fiber, about 10 percent rubbed; massive; very friable; many fine roots; primarily herbaceous fibers; medium acid; clear wavy boundary.

Cg1—24 to 29 inches; gray (2.5Y 6/1) sandy loam; massive; friable; medium acid; abrupt smooth boundary.

Cg2—29 to 55 inches; greenish gray (5GY 6/1) loam; massive; firm; neutral; gradual wavy boundary.

Cg3—55 to 60 inches; gray (10YR 5/1) clay loam; massive; firm; neutral.

The organic layers are 16 to 40 inches thick. Reaction in the organic layers ranges from strongly acid to neutral. The Cg horizon has hue of 2.5Y and 10YR, value of 5 or 6, and chroma of 1 or 2. Gleyed hue of 5GY and 5G and value of 6 and chroma of 1 are also common. The Cg horizon is sandy loam, loam, silt loam, or clay loam.

Croswell Series

The Croswell series consists of moderately well drained, rapidly permeable soils on outwash plains, till plains, and moraines. The soils formed in sandy glacial drift material. The slope ranges from 0 to 3 percent.

Croswell soils are similar to East Lake soils and are similar and commonly adjacent to AuGres, Kalkaska, and Rubicon soils. Kalkaska and Rubicon soils are better drained than Croswell soils. In addition, Kalkaska soils have a more developed spodic horizon. AuGres soils are somewhat poorly drained.

Typical pedon of Croswell sand, 0 to 3 percent slopes, 1,100 feet east and 100 feet north of the southwest corner of sec. 22, T. 22 N., R. 8 W.

A—0 to 3 inches; very dark gray (10YR 3/1) sand, gray (10YR 5/1) dry; single grained; loose; many medium roots; very strongly acid; abrupt smooth boundary.

E—3 to 7 inches; pinkish gray (7.5YR 6/2) sand; single grained; loose; many fine roots; medium acid; abrupt irregular boundary.

Bs1—7 to 17 inches; dark brown (7.5YR 4/4) sand; single grained; loose; few fine roots; slightly acid; gradual wavy boundary.

Bs2—17 to 31 inches; strong brown (7.5YR 5/6) sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; medium acid; gradual wavy boundary.

C—31 to 60 inches; light yellowish brown (10YR 6/4) sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; few pebbles; slightly acid.

The solum is 24 to 40 inches thick. Pebbles range from 0 to 5 percent throughout. Reaction ranges from very strongly acid to slightly acid.

In cultivated areas an Ap horizon has hue of 10YR, value of 2 to 4, and chroma of 2. The A horizon has value of 2 or 3 and chroma of 1. It is dominantly sand, but the range includes loamy sand. The Bs horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 3 to 6. The C horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 3 to 6. It ranges from medium acid to neutral.

Dighton Series

The Dighton series consists of well drained soils on till plains and moraines. The soils formed in fine textured deposits over coarse textured deposits. Permeability is moderately slow in the upper part of the pedon and rapid in the lower part. The slope ranges from 1 to 6 percent.

These soils are taxadjuncts to the Dighton series because they have tonguing of albic materials into the argillic horizon and have thin bands of sandy loam in the substratum. These differences, however, do not affect the use or behavior of the soils.

Dighton soils are similar to Nester soils and commonly are adjacent to Nester, Manistee, and Montcalm soils. Nester soils have a clay loam substratum. Manistee and Montcalm soils have a spodic horizon and are in the upper part of the solum. In addition, Manistee soils have a clay substratum.

Typical pedon of Dighton sandy loam, 1 to 6 percent slopes, 1,400 feet east and 20 feet north of the southwest corner of sec. 35, T. 22 N., R. 8 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) dry; moderate medium granular structure; friable; many medium roots; about 1 percent pebbles; slightly acid; abrupt smooth boundary.

B/E—10 to 17 inches; brown (7.5YR 5/4) clay loam (Bt); tongues of light brownish gray (10YR 6/2) loam on faces of peds (E); strong medium angular blocky structure; firm; common fine roots; about 1 percent pebbles; slightly acid; clear irregular boundary.

Bt—17 to 33 inches; dark brown (7.5YR 4/4) clay loam; strong coarse angular blocky structure; firm; thin to thick continuous clay films on faces of peds; few fine roots; about 1 percent pebbles; slightly acid; gradual wavy boundary.

C1—33 to 39 inches; brown (10YR 5/3) clay loam; weak coarse angular blocky structure; firm; few fine roots; about 1 percent pebbles; slight effervescence; mildly alkaline; clear wavy boundary.

2C2—39 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; few bands of brown (7.5YR 5/4) sandy loam 1/2 to 3 inches thick; weak medium granular structure; friable; neutral.

The thickness of the solum and the depth to carbonates range from 20 to 40 inches. The content of pebbles ranges from 0 to 3 percent throughout. Reaction ranges from slightly acid to strongly acid.

The Ap horizon has chroma of 1 or 2. It is 6 to 10 inches thick. The Ap horizon dominantly is sandy loam, but the range includes loam.

In undisturbed areas, there is an A horizon and an E horizon. The A horizon is 1 to 3 inches thick. It has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon is 1 to 4 inches thick. It has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2.

The Bt horizon has hue of 10YR, 7.5YR, or 5YR and value of 3 or 4. It is clay loam or silty clay loam. There is no C1 horizon in some pedons. In some pedons, there are no sandy loam or loamy sand bands in the 2C2 horizon.

East Lake Series

The East Lake series consists of somewhat excessively drained, rapidly permeable soils on outwash plains. The soils formed in sandy glacial drift material. The slope ranges from 0 to 30 percent.

East Lake soils are similar to Croswell, Kalkaska, and Rubicon soils and commonly are adjacent to Gladwin and Rubicon soils. Croswell soils are moderately well drained. Gladwin soils are somewhat poorly drained and have an argillic horizon. Kalkaska and Rubicon soils do not have calcareous gravelly sand in the substratum. In addition, Kalkaska soils have a more developed spodic horizon than the East Lake soils.

Typical pedon of East Lake sand in an area of East Lake-Rubicon sands, 0 to 6 percent slopes, 200 feet north and 100 feet east of the center of sec. 27, T. 22 N., R. 8 W.

A—0 to 2 inches; very dark gray (10YR 3/1) sand, dark gray (10YR 4/1) dry; very weak fine granular structure; very friable; many fine roots; about 5 percent pebbles; medium acid; abrupt smooth boundary.

E—2 to 4 inches; grayish brown (10YR 5/2) sand; single grained; loose; many fine roots; about 5 percent pebbles; medium acid; abrupt broken boundary.

Bs1—4 to 10 inches; dark brown (7.5YR 4/4) sand; single grained; loose; few fine roots; about 15 percent pebbles; medium acid; clear wavy boundary.

Bs2—10 to 20 inches; strong brown (7.5YR 5/6) sand; single grained; loose; few fine roots; about 15 percent pebbles; medium acid; clear irregular boundary.

BC—20 to 28 inches; yellowish brown (10YR 5/6) sand; single grained; loose; about 10 percent pebbles; neutral; clear wavy boundary.

2C—28 to 60 inches; yellowish brown (10YR 5/4) gravelly sand; single grained; loose; about 20 percent pebbles; strong effervescence; moderately alkaline.

The solum is 20 to 40 inches thick. The depth to carbonates ranges from 20 to 40 inches. The content of pebbles ranges from 1 to 15 percent throughout. Reaction ranges from medium acid to neutral.

In cultivated areas, an Ap horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 1 or 2.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. It is 2 to 4 inches thick. The E horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 1 or 2. The A horizon dominantly is sand, but the range includes loamy sand and gravelly loamy sand. The Bs horizon has hue of 10YR to 5YR, value of 4 or 5, and chroma of 4 to 6. The BC horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 4 to 6. The 2C horizon has hue of 10YR, value of 5 or 6, and chroma of 3 or 4. It is mildly alkaline or moderately alkaline.

Emmet Series

The Emmet series consists of well drained, moderately permeable soils on moraines. The soils formed in loamy deposits. The slope ranges from 0 to 30 percent.

Emmet soils are adjacent to Graycalm, Montcalm, and Nester soils. Graycalm and Montcalm soils are less clayey than the Emmet soils. In addition, Montcalm soils have a spodic horizon and are coarser textured. Nester soils have more clay in the subsoil and substratum.

Typical pedon of Emmet sandy loam, in an area of Emmet-Montcalm complex, 0 to 6 percent slopes, 300 feet west and 100 feet south of the center of sec. 25, T. 21 N., R. 8 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) dry; moderate medium granular structure; friable; few fine roots; about 2 percent pebbles and cobbles; slightly acid; abrupt smooth boundary.

Bw—9 to 17 inches; dark brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure; friable; few fine roots; about 2 percent pebbles and cobbles; medium acid; clear wavy boundary.

E—17 to 22 inches; brown (10YR 5/3) sandy loam; weak medium subangular blocky structure; very friable; few fine roots; about 2 percent pebbles and cobbles; medium acid; abrupt irregular boundary.

Bt—22 to 43 inches; dark brown (7.5YR 4/4) sandy loam; some brown (10YR 5/3) coatings from E horizon on faces of peds; moderate medium subangular blocky structure; friable; few clay films on some peds; about 2 percent pebbles and cobbles; neutral; clear wavy boundary.

C—43 to 60 inches; pale brown (10YR 6/3) sandy loam; few discontinuous lenses of loamy sand and loam; weak medium subangular blocky structure; friable; about 4 percent pebbles and cobbles; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 24 to 45 inches. Pebble and cobble content ranges from 0 to 15 percent throughout. Reaction ranges from medium acid in the upper part of the solum to mildly alkaline in the Bt horizon.

The Ap horizon has value of 3 or 4 and chroma of 2. It is 6 to 9 inches thick.

In undisturbed areas, there is an A horizon and an E horizon. The A horizon has hue of 10YR, value of 3, and chroma of 1 or 2. It is 1 to 6 inches thick. The A horizon is loamy sand or sandy loam. The E horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 1 to 3.

The Bs horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. The Bt horizon is sandy loam or sandy clay loam. In some pedons, the C horizon has lenses of loam, loamy sand, or sand.

Gladwin Series

The Gladwin series consists of somewhat poorly drained soils on outwash plains. The soils formed in sandy and loamy glacial drift material. Permeability is moderately rapid in the upper part of the pedon and very rapid in the lower part. The slope ranges from 0 to 3 percent.

Gladwin soils are similar to AuGres and Otisco soils and commonly are adjacent to East Lake, Iosco, and Roscommon soils. AuGres soils do not have an argillic horizon. Otisco soils do not have a gravelly sand substratum. Unlike the Gladwin soils, East Lake soils are somewhat excessively drained and do not have an argillic horizon. Iosco soils have finer textured material in the lower part of the profile than the Gladwin soils. Roscommon soils do not have a spodic horizon or an argillic horizon and are poorly drained.

Typical pedon of Gladwin loamy sand, 0 to 3 percent slopes, 1,350 feet east and 75 feet north of the center of sec. 4, T. 21 N., R. 8 W.

A—0 to 4 inches; black (10YR 2/1) loamy sand, gray (10YR 5/1) dry; weak fine granular structure; very friable; few fine roots; about 5 percent pebbles; slightly acid; abrupt smooth boundary.

E—4 to 7 inches; light brownish gray (10YR 6/2) loamy sand; single grained; loose; few fine roots; about 5 percent pebbles; slightly acid; abrupt wavy boundary.

Bs1—7 to 12 inches; reddish brown (5YR 4/4) sand; few fine distinct strong brown (7.5YR 5/6) mottles; single grained; loose; few fine roots; about 5 percent pebbles; slightly acid; clear wavy boundary.

Bs2—12 to 16 inches; dark brown (7.5YR 4/4) sand; few fine distinct yellowish brown (7.5YR 5/6) mottles; single grained; loose; few fine roots; about 5 percent pebbles; slightly acid; clear wavy boundary.

Bt—16 to 24 inches; dark brown (7.5YR 4/4) gravelly sandy loam; few fine distinct yellowish brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; few fine roots; about 15 percent pebbles; neutral; clear wavy boundary.

C—24 to 60 inches; pale brown (10YR 6/3) gravelly sand; single grained; loose; about 15 percent pebbles; strong effervescence; moderately alkaline.

The solum is 20 to 40 inches thick. The depth to carbonates ranges from 20 to 40 inches. Pebbles and cobbles range from 5 to 25 percent throughout. Reaction ranges from slightly acid to mildly alkaline.

In cultivated areas, an Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The Ap horizon is 6 to 10 inches thick. It is loamy sand or sand.

The Bs horizon has hue of 10YR, 7.5YR, or 5YR and value of 3 or 4. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is gravelly sandy loam, sandy loam, or gravelly loamy sand. The C horizon has hue of 10YR or 7.5YR, value or 5 or 6, and chroma of 2 or 3.

Graycalm Series

The Graycalm series consists of somewhat excessively drained, rapidly permeable soils on outwash plains, till plains, and moraines. The soils formed in coarse textured deposits. The slope ranges from 0 to 30 percent.

The Graycalm soils are similar to the Grayling soils and commonly are adjacent to Montcalm and Rubicon soils. Unlike Graycalm soils, Grayling soils do not have thin bands of loamy sand or sandy loam. Montcalm soils have a spodic horizon and have finer textured argillic bands than those of Graycalm soils. Rubicon soils have a spodic horizon and do not have an argillic horizon.

Typical pedon of Graycalm sand, in an area of Graycalm-Rubicon sands, 0 to 6 percent slopes, 300 feet west and 600 feet north of the southeast corner of sec. 18, T. 22 N., R. 8 W.

A—0 to 2 inches; very dark gray (10YR 3/1) sand and leaf litter, dark gray (10YR 4/1) dry; some grayish brown (10YR 5/2) sand (E); very weak fine granular structure; very friable; many medium roots; very strongly acid; abrupt smooth boundary.

Bw1—2 to 5 inches; strong brown (7.5YR 5/6) sand; single grained; loose; many medium roots; strongly acid; clear irregular boundary.

Bw2—5 to 24 inches; yellowish brown (10YR 5/6) sand; single grained; loose; few medium roots; strongly acid; gradual wavy boundary.

E—24 to 44 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; few fine roots; strongly acid; abrupt broken boundary.

E&Bt—44 to 60 inches; light yellowish brown (10YR 6/4) sand (E); single grained; thin discontinuous bands of dark brown (7.5YR 4/4) loamy sand and sandy loam (Bt); weak medium subangular blocky structure; friable; medium acid.

The solum is 40 to 60 inches thick. The depth to the Bt horizon ranges from 25 to 48 inches. Pebbles range from 0 to 15 percent throughout. Reaction ranges from very strongly acid to slightly acid.

In cultivated areas, an Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. It is 4 to 6 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. The A horizon is 2 to 5 inches thick. It is sand or loamy sand. In some pedons, there is a 1- to 3-inch E horizon between the A horizon and the Bw horizon. The Bw horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. It is sand or loamy sand. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. The Bt horizon has bands that are 1/4 inch to 2 inches thick. These bands are loamy sand or sandy loam.

Grayling Series

The Grayling series consists of excessively drained, rapidly permeable soils on outwash plains. The soils formed in coarse textured deposits. The slope ranges from 0 to 6 percent.

The Grayling soils are similar to Graycalm soils and commonly are adjacent to AuGres, Croswell, and Rubicon soils. AuGres, Croswell, and Rubicon soils have an albic horizon and a spodic horizon. In addition, AuGres soils have mottles in the upper part of the solum and Croswell soils in the lower part. Graycalm soils have bands of loamy sand at a depth of more than 40 inches.

Typical pedon of Grayling sand, 0 to 6 percent slopes, 60 feet west and 100 feet south of the northeast corner of sec. 35, T. 21 N., R. 5 W.

A—0 to 3 inches; black (10YR 2/1) sand, dark gray (10YR 4/1) dry; some grayish brown (10YR 5/2) uncoated sand grains (E); very weak medium granular structure; very friable; many fine and coarse roots; very strongly acid; abrupt smooth boundary.

Bw1—3 to 7 inches; dark yellowish brown (10YR 4/4) sand; very weak medium granular structure; very friable; many medium and fine roots; strongly acid; clear wavy boundary.

Bw2—7 to 19 inches; dark yellowish brown (10YR 4/6) sand; very weak fine granular structure; very friable; common medium and fine roots; strongly acid; clear wavy boundary.

BC—19 to 28 inches; yellowish brown (10YR 5/6) sand; single grained; loose; few fine roots; medium acid; gradual wavy boundary.

C—28 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; medium acid.

The solum is 15 to 30 inches thick.

The A horizon has hue of 10YR, value of 2 to 4, and chroma of 1 or 2. It is 2 to 3 inches thick. In some pedons, a separate E horizon has hue of 10YR, value of 5 or 6, and chroma of 2. It is 1 to 2 inches thick. The Bw horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 4 to 8. The C horizon has value of 6 or 7 and chroma of 2 to 4.

Iosco Series

The Iosco series consists of somewhat poorly drained soils on till plains and outwash plains. The soils formed in coarse textured and moderately coarse textured deposits underlain by medium textured or moderately fine textured deposits. Permeability is rapid in the upper part of the pedon and moderately slow in the lower part. The slope ranges from 0 to 3 percent.

Iosco soils commonly are adjacent to AuGres and Kawkawlin soils. AuGres soils do not have a fine textured subsoil. Kawkawlin soils do not have a spodic horizon and have a fine textured solum.

Typical pedon of Iosco loamy sand, 0 to 3 percent slopes, 350 feet north and 1,800 feet east of the southwest corner of sec. 14, T. 21 N., R. 8 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loamy sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine roots; medium acid; abrupt smooth boundary.

E—9 to 11 inches; light brownish gray (10YR 6/2) loamy sand; weak fine granular structure; very friable; common fine roots; medium acid; abrupt broken boundary.

Bs—11 to 26 inches; dark brown (7.5YR 4/4) sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grained; loose; few fine roots; few pieces of weakly cemented dark reddish brown (5YR 3/4) ortstein; strongly acid; abrupt wavy boundary.

2B/E—26 to 31 inches; dark brown (7.5YR 4/4) sandy loam (Bt); coatings of light brownish gray (10YR 6/2) loamy sand (E') on faces of peds and as fillings in cracks; common medium distinct strong brown (7.5YR 5/2) mottles; moderate medium subangular blocky structure; firm; few fine roots; neutral; gradual wavy boundary.

2Bt—31 to 46 inches; dark brown (7.5YR 4/4) sandy loam; many medium distinct strong brown (7.5YR 5/6) and many fine distinct brown (7.5YR 5/2) mottles; moderate medium subangular blocky structure; firm; thin clay films; mildly alkaline; gradual wavy boundary.

3C—46 to 60 inches; brown (7.5YR 5/2) loam; common medium distinct yellowish brown (10YR 5/4) mottles; massive; firm; strong effervescence; moderately alkaline.

The depth to the 2Bt horizon ranges from 20 to 40 inches. Reaction in the part of the solum ranges from strongly acid to slightly acid.

The Ap horizon has value of 3 or 4 and chroma of 1 or 2. It is 6 to 10 inches thick. The Ap horizon dominantly is loamy sand, but the range includes sand. The Bs horizon has hue of 7.5YR or 10YR, value of 4 to 5, and chroma of 4 to 6. It is sand or loamy sand. The 2Bt horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 or 5, and chroma of 3 to 6. It is loam or sandy loam. Reaction ranges from slightly acid to mildly alkaline. The 3C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4.

In undisturbed areas, an A horizon is 1 to 4 inches thick. It has hue of 10YR, value of 3, and chroma of 1.

Kalkaska Series

The Kalkaska series consists of somewhat excessively drained, rapidly permeable soils on outwash plains and moraines. The soils formed in sandy glacial drift material. The slope ranges from 0 to 30 percent.

Kalkaska soils are similar to Croswell, East Lake, and Rubicon soils and commonly are adjacent to Montcalm and Rubicon soils. Kalkaska soils have a more developed spodic horizon than all of these soils. Unlike Kalkaska soils, East Lake soils have a calcareous, gravelly sand substratum. Montcalm soils have an argillic horizon.

Typical pedon of Kalkaska sand, 0 to 6 percent slopes, 300 feet east and 350 feet north of the southwest corner of sec. 33, T. 24 N., R. 7 W.

A—0 to 3 inches; black (10YR 2/1) sand and leaf litter and grains from the E horizon, grayish brown (10YR 5/2) dry; very weak fine granular structure; many medium roots; very strongly acid; abrupt smooth boundary.

E—3 to 6 inches; pinkish gray (7.5YR 6/2) sand; single grained; loose; many medium roots; very strongly acid; abrupt broken boundary.

Bh—6 to 9 inches; dark reddish brown (5YR 2/2) sand; weak medium granular structure; very friable; some fragments of weakly cemented ortstein; common medium roots; very strongly acid; abrupt irregular boundary.

Bhs—9 to 14 inches; dark reddish brown (5YR 3/3) sand; single grained; loose; a few pieces of weakly cemented ortstein; common medium roots; strongly acid; clear wavy boundary.

Bs—14 to 32 inches; strong brown (7.5YR 5/6) sand; single grained; loose; few fine roots; strongly acid; gradual wavy boundary.

BC—32 to 40 inches; yellowish brown (10YR 5/6) sand; single grained; loose; medium acid; gradual wavy boundary.

C—40 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; medium acid.

The solum is 30 to 48 inches thick. The content of pebbles ranges from 0 to 5 percent throughout. Reaction ranges from medium acid to very strongly acid.

In cultivated areas, an Ap horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 1 or 2. It is 5 to 9 inches thick.

The A horizon is 1 to 3 inches thick. The E horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 1 or 2. The A horizon and the E horizon dominantly are sand, but the range includes loamy sand. The Bh horizon has hue of 5YR or 7.5YR, value of 2 or 3, and chroma of 2 or 3. The Bs horizon has hue of 5YR or

7.5YR, value of 3 to 5, and chroma of 3 to 6. The BC horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 4 to 6. The C horizon is medium acid or slightly acid.

Kawkawlin Series

The Kawkawlin series consists of somewhat poorly drained, moderately slowly permeable soils on till plains. The soils formed in moderately fine textured and fine textured deposits. The slope ranges from 0 to 3 percent.

Kawkawlin soils are similar to Nester and Kawkawlin Variant soils and commonly are adjacent to Iosco and Sims soils. Iosco soils have a spodic horizon and a sandy solum. Nester soils do not have mottles in the upper part of the subsoil. Kawkawlin Variant soils are sandy in the lower part of the substratum. Sims soils are poorly drained and do not have an argillic horizon.

Typical pedon of Kawkawlin loam, 0 to 3 percent slopes, 50 feet south and 1,100 feet east of the northwest corner of sec. 23, T. 22 N., R. 8 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak medium granular structure; friable; few fine roots; about 1 percent pebbles; neutral; abrupt smooth boundary.

B/E—8 to 12 inches; dark brown (7.5YR 4/4) clay (Bt); coatings of grayish brown (10YR 5/2) loam (E) on faces of peds; common medium distinct strong brown (7.5YR 5/6) and grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; friable; few fine roots; about 1 percent pebbles; medium acid; clear irregular boundary.

Bt—12 to 35 inches; dark brown (7.5YR 4/4) clay; common medium distinct strong brown (7.5YR 5/6) and grayish brown (10YR 5/2) mottles; strong coarse angular blocky structure; firm; thick clay films on faces of peds; slightly acid; gradual wavy boundary.

C—35 to 60 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct grayish brown (10YR 5/2) mottles; massive; firm; strong effervescence; moderately alkaline.

The solum is 20 to 40 inches thick. The depth to carbonates ranges from 20 to 40 inches. Pebbles range from 0 to 5 percent throughout. Reaction ranges from strongly acid to mildly alkaline.

In undisturbed areas, there is an A horizon and an E horizon. The A horizon is 1 to 4 inches thick. It has hue of 10YR, value of 3, and chroma of 1. The E horizon is 1 to 5 inches thick. It has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2.

Kawkawlin Variant

The Kawkawlin Variant consists of somewhat poorly drained, moderately slowly permeable over rapidly permeable soils on till plains. The soils formed in moderately fine textured deposits over coarse textured deposits. The slope ranges from 0 to 3 percent.

The Kawkawlin Variant soils are commonly adjacent to Kawkawlin and Dighton soils. Unlike the Kawkawlin Variant soils, Kawkawlin soils do not have sand in the substratum. Dighton soils are well drained.

Typical pedon of Kawkawlin Variant sandy loam, 0 to 3 percent slopes, 800 feet north and 450 feet east of the southwest corner of sec. 14, T. 23 N., R. 6 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) sandy loam, grayish brown (10YR 6/2) dry; weak medium granular structure; friable; common fine roots; medium acid; abrupt smooth boundary.

B/E—8 to 12 inches; yellowish brown (10YR 5/4) clay loam (Bt); tongues of light brownish gray (10YR 6/2) sandy loam on faces of peds (E); common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; few fine roots; slightly acid; abrupt broken boundary.

Bt—12 to 28 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct strong brown (7.5YR 5/6) and light brownish gray (10YR 6/2) mottles; moderate medium subangular blocky structure; firm; few fine roots; many thin discontinuous grayish brown (10YR 5/3) coatings on faces of peds; slightly acid; gradual wavy boundary.

C1—28 to 33 inches; brown (10YR 5/3) clay loam; few medium distinct yellowish brown (10YR 5/6) mottles and many medium distinct light brownish gray (10YR 6/2) mottles; massive; firm; mildly alkaline; slight effervescence; abrupt wavy boundary.

2C2—33 to 60 inches; brown (10YR 5/3) sand; single grained; loose; neutral.

The solum generally is 24 to 35 inches thick, but the range is 20 to 40 inches. Pebbles range from 0 to 3 percent throughout. Reaction ranges from slightly acid to strongly acid.

In undisturbed areas, there is an A horizon and an E horizon. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is 2 to 4 inches thick. The E horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2. It is 2 to 4 inches thick.

The Ap horizon has chroma of 1 or 2. The Ap horizon is 6 to 10 inches thick. It is dominantly sandy loam, but the range includes loam and silt loam. The Bt horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 or 5, and chroma of 3 or 4. It is clay loam, clay, or silty clay loam. In some pedons, there is no C1 horizon. The 2C2 horizon has value of 5 to 7 and chroma of 2 or 3.

Loxley Series

The Loxley series consists of very poorly drained, moderately slowly permeable to moderately rapidly permeable soils in bogs on outwash plains, till plains, and moraines. The soils formed in deep, herbaceous organic deposits. The slope ranges from 0 to 2 percent.

Loxley soils are similar to Lupton soils and commonly are adjacent to Tawas soils. Lupton soils do not have a hemic surface layer and are less acid than the Loxley soils. Tawas soils have thinner organic layers than the Loxley soils.

Typical pedon of Loxley mucky peat, 600 feet south and 300 feet east of the northwest corner of sec. 18, T. 22 N., R. 8 W.

Oe—0 to 5 inches; dark brown (7.5YR 3/2) broken face and rubbed hemic material, dark brown (7.5YR 3/2) dry; about 80 percent fibers, 35 percent rubbed; weak thick platy structure; very friable; many fine roots; primarily sphagnum and herbaceous fibers; extremely acid; abrupt smooth boundary.

Oa1—5 to 9 inches; black (10YR 2/1) broken face and rubbed sapric material; about 25 percent fibers, 5 percent rubbed; weak medium granular structure; very friable; many fine roots; primarily herbaceous material; extremely acid; abrupt smooth boundary.

Oa2—9 to 45 inches; dark reddish brown (5YR 3/3) broken face, dark reddish brown (5YR 3/2) rubbed sapric material; about 55 percent fibers, 15 percent rubbed; weak thick platy structure; very friable; few fine roots; primarily herbaceous material; extremely acid; gradual wavy boundary.

Oa3—45 to 60 inches; dark reddish brown (5YR 2/2) broken face, black (5YR 2/1) rubbed sapric material; about 25 percent fibers, less than 5 percent rubbed; massive; very friable; primarily herbaceous material; very strongly acid.

The organic layers are 51 inches thick or more. The organic material has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3, and chroma of 2 or 3. Reaction ranges from extremely acid to very strongly acid throughout.

Lupton Series

The Lupton series consists of very poorly drained soils in depressions on outwash plains, till plains, and moraines. Permeability is moderately slow to moderately rapid. The soils formed in deep herbaceous organic deposits. The slope ranges from 0 to 2 percent.

Lupton soils are similar to Carbondale and Loxley soils and commonly are adjacent to Carbondale, Cathro, and Tawas soils. Loxley soils have a hemic surface layer and are more acid than the Lupton soils. Carbondale soils have hemic material in the bottom tiers. Cathro and Tawas soils have thinner organic layers than Lupton soils.

Typical pedon of Lupton muck, 2,100 feet south and 250 feet west of the northeast corner of sec. 22, T. 21 N., R. 7 W.

Oa1—0 to 7 inches; black (5YR 2/1) broken face and rubbed sapric material, dark reddish brown (5YR 2.5/2) dry; about 10 percent fibers, less than 5 percent rubbed; weak fine granular structure; very friable; woody and herbaceous fibers; about 5 percent coarse woody fragments; many fine roots; slightly acid; clear smooth boundary.

Oa2—7 to 25 inches; black (5YR 2/1) broken face and rubbed sapric material; about 20 percent fibers, less than 10 percent rubbed; weak fine granular structure; very friable; primarily woody fibers; about 15 percent coarse woody fragments; few fine roots; neutral; gradual wavy boundary.

Oa3—25 to 40 inches; black (5YR 2/1) broken face and rubbed sapric material; about 30 percent fibers, less than 10 percent rubbed; massive; very friable; primarily herbaceous fibers; few fine roots; neutral; gradual wavy boundary.

Oa4—40 to 60 inches; black (5YR 2/1) broken face and rubbed sapric material; about 40 percent fibers, less than 10 percent rubbed; massive; very friable; primarily herbaceous fibers; neutral.

The organic layers are 51 inches thick or more. Woody fragments make up as much as 25 percent of the volume in some pedons. Reaction ranges from strongly acid to mildly alkaline.

Typically, the surface tier is sapric material. However, in some pedons, there is hemic material or various proportions of hemic and sapric materials. In a few pedons, layers of hemic material, less than 10 inches thick, are in the subsurface tier.

Manistee Series

The Manistee series consists of well drained soils on moraines and till plains. The soils formed in coarse textured deposits underlain by fine textured deposits. Permeability is rapid in the upper part of the pedon and slow in the lower part. The slope ranges from 0 to 12 percent.

Manistee soils are commonly adjacent to Montcalm and Nester soils. Montcalm soils have less clay in the subsoil and substratum than Manistee soils. Nester soils do not have a spodic horizon. They dominantly have a moderately fine textured solum.

Typical pedon of Manistee loamy sand, 0 to 6 percent slopes, 900 feet north and 1,500 feet west of the southeast corner of sec. 34, T. 22 N., R. 8 W.

Ap—0 to 10 inches; dark brown (10YR 3/3) loamy sand, grayish brown (10YR 5/2) dry; very weak fine granular structure; very friable; few fine roots; slightly acid; abrupt smooth boundary.

Bs—10 to 22 inches; strong brown (7.5YR 5/6) sand; single grained; loose; few fine roots; strongly acid; clear wavy boundary.

E—22 to 24 inches; light brownish gray (10YR 6/2) sand; single grained; loose; few fine roots; slightly acid; abrupt broken boundary.

2Bt—24 to 40 inches; dark brown (7.5YR 4/4) clay; moderate medium angular blocky structure; firm; few thin discontinuous clay films on peds; few fine roots; about 3 percent pebbles; slightly acid; abrupt wavy boundary.

2C—40 to 60 inches; brown (7.5YR 5/4) clay; massive; firm; about 3 percent pebbles; mildly alkaline.

The depth to the 2Bt horizon ranges from 20 to 40 inches. Reaction in the sandy part of the solum ranges from strongly acid to slightly acid. Reaction in the 2Bt and 2C horizons ranges from slightly acid to moderately alkaline.

The Ap horizon has value of 3 or 4 and chroma of 2 or 3. It is 6 to 10 inches thick. The Ap horizon dominantly is loamy sand, but the range includes sand.

In undisturbed areas, there is an A horizon and an E horizon. The A horizon is 1 to 4 inches thick. It has hue of 10YR, value of 2 or 3, and chroma of 1. The E horizon is 1 to 6 inches thick. It has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2. In some places an E' horizon occurs as thick coatings on the faces of peds in the Bt horizon.

The Bs horizon has hue of 10YR, 7.5YR, or 5YR, value of 3 to 5, and chroma of 2 to 6.

Montcalm Series

The Montcalm series consists of well drained, moderately rapidly permeable soils on moraines, till plains, and outwash plains. The soils formed in coarse and moderately coarse textured glacial till. The slope ranges from 0 to 30 percent.

Montcalm soils commonly are adjacent to Emmet, Graycalm, Rubicon, and Kalkaska soils. Emmet soils are loamy and do not have a spodic horizon. Graycalm soils do not have a spodic horizon and generally have coarser textured argillic bands. Rubicon and Kalkaska soils do not have an argillic horizon.

Typical pedon of Montcalm loamy sand, in an area of Montcalm-Graycalm complex, 0 to 6 percent slopes, 300 feet east and 1,800 feet north of the southwest corner of sec. 24, T. 23 N., R. 8 W.

A—0 to 3 inches; very dark gray (10YR 3/1) loamy sand, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; many fine and medium roots; about 2 percent pebbles; extremely acid; abrupt smooth boundary.

E—3 to 7 inches; pinkish gray (7.5YR 6/2) loamy sand; weak fine granular structure; very friable; many fine and medium roots; about 2 percent pebbles; extremely acid; abrupt wavy boundary.

Bs1—7 to 14 inches; dark brown (7.5YR 4/4) loamy sand; weak fine granular structure; very friable; some fragments of weakly cemented dark reddish brown (5YR 3/5) ortstein in the top inch; many fine and medium roots; about 2 percent pebbles; very strongly acid; clear wavy boundary.

Bs2—14 to 21 inches; yellowish brown (10YR 5/6S) loamy sand; weak fine granular structure; very friable; few fine roots; very strongly acid; clear wavy boundary.

E'—21 to 30 inches; yellowish brown (10YR 5/4) loamy sand; weak fine granular structure; very friable; few fine roots; very strongly acid; clear wavey boundary.

E&Bt—30 to 60 inches; light yellowish brown (10YR 6/4) sand (E'); single grained; loose; medium acid; bands of dark brown (7.5YR 4/4) sandy loam about 1/2 to 6 inches thick (Bt), total accumulated thickness of Bt is 12 inches; moderate medium subangular structure; very thin discontinuous brown (7.5YR 5/2) clay films; friable; medium acid.

The solum is 50 to more than 60 inches thick. Pebbles and cobbles range from 1 to 15 percent throughout. Reaction ranges from slightly acid to strongly acid.

The A horizon has value of 3 or 4 and chroma of 1 or 2. In cultivated areas, there is an Ap horizon 6 to 9 inches thick. In some pedons, particularly in cultivated areas, there is no E horizon. The Bs horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 4 to 6. It is sand or loamy sand. The E' horizon is sand or loamy sand. The Bt horizon is sandy loam, sandy clay loam, or loamy sand. The Bt horizon occurs as bands that are 1/2 inch to 5 inches thick.

Nester Series

The Nester series consists of well drained, moderately slowly permeable soils on moraines and till plains. The soils formed in moderately fine textured and fine textured deposits. The slope ranges from 1 to 12 percent.

Nester soils are similar to Dighton and Kawkawlin soils and commonly are adjacent to Manistee and Montcalm soils. Dighton soils have a sandy substratum. Kawkawlin soils are somewhat poorly drained. Manistee soils have a spodic horizon and are sandy in the upper part of the solum. Montcalm soils have a spodic horizon and are coarser textured than the Nester soils.

Typical pedon of Nester sandy loam, 1 to 6 percent slopes, 50 feet north and 2,800 feet west of the southeast corner of sec. 13, T. 22 N., R. 8 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; friable; common medium roots; about 1 percent pebbles; neutral; abrupt smooth boundary.

B/E—9 to 17 inches; dark brown (7.5YR 4/4) clay loam (Bt); moderate medium subangular blocky structure; firm; grayish brown (10YR 5/2) sandy loam (E);

moderate medium granular structure; friable; the E is mainly thick coatings on the faces of peds of Bt material; few fine roots; about 1 percent pebbles; medium acid; clear wavy boundary.

Bt—17 to 38 inches; dark brown (7.5YR 4/4) clay; strong medium angular blocky structure; firm; few medium roots; thick clay films; about 2 percent pebbles; medium acid; gradual wavy boundary.

C—38 to 60 inches; brown (7.5YR 5/4) clay loam; massive; firm; about 2 percent pebbles; strong effervescence; moderately alkaline.

The solum is 24 to 40 inches thick. The solum depth to carbonates range from 24 to 40 inches. Reaction ranges from neutral to medium acid.

The Ap horizon has value of 3 or 4 and chroma of 1 or 2. It is 6 to 9 inches thick. The Ap horizon dominantly is sandy loam, but the range includes loam and clay loam.

In undisturbed areas, there is an A horizon and an E horizon. The A horizon is 1 to 3 inches thick. It has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon is 1 to 4 inches thick. It has hue of 10YR, value of 5 or 6, and chroma of 2.

The Bt horizon is clay, clay loam, or silty clay loam.

Otisco Series

The Otisco series consists of somewhat poorly drained, moderately rapidly or rapidly permeable soils on outwash plains and till plains. The soils formed in sandy glacial drift material. The slope ranges from 0 to 3 percent.

Otisco soils are similar to AuGres and Gladwin soils and commonly are adjacent to AuGres and Roscommon soils. AuGres and Gladwin soils do not have an argillic horizon. Gladwin soils have a gravelly sand substratum. Roscommon soils are poorly drained and do not have a spodic horizon.

A—0 to 3 inches; black (10YR 2/1) loamy sand and leaf litter and grains from the E horizon, dark gray (10YR 4/1) dry; weak medium granular structure; very friable; many coarse roots; strongly acid; abrupt smooth boundary.

E—3 to 8 inches; grayish brown (10YR 5/2) loamy sand; very weak medium crumb structure; very friable; many coarse roots; medium acid; abrupt wavy boundary.

Bs—8 to 16 inches; dark brown (7.5YR 4/4) loamy sand; few fine faint strong brown (7.5YR 5/6) mottles; very weak fine crumb structure; very friable; medium fine roots; slightly acid; clear wavy boundary.

E&Bt—16 to 55 inches; light yellowish brown (10YR 6/4) sand (E'); single grained; loose; bands of yellowish brown (10YR 5/6) sandy loam (Bt); common medium distinct light brownish gray (10YR 6/2) and strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; few fine roots; medium acid; gradual wavy boundary.

C—55 to 60 inches; yellowish brown (10YR 5/4) sand; few fine distinct grayish brown (10YR 5/2) mottles; single grained; loose; medium acid.

The solum is 30 to 55 inches thick. Pebbles range from 0 to 3 percent throughout.

In cultivated areas, an Ap horizon has hue of 7.5YR or 10YR, value of 3 or 4, and chroma of 1 or 2.

The A horizon has chroma of 1 or 2. The E horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 1 or 2. The A horizon dominantly is loamy sand, but the range includes sand. Reaction ranges from strongly acid to slightly acid. The Bs horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is sand or loamy sand and ranges from strongly acid to slightly acid. The E part of the E&Bt horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 3 or 4. It is sand or loamy sand. The Bt part of the E&Bt horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 6. It is loamy sand, sandy loam, or sandy clay loam. The Bt horizon occurs as bands that are 1/4 inch to 4 inches thick. The C horizon has value of 5 to 7 and chroma of 2 to 4. The C horizon ranges from medium acid to neutral.

Roscommon Series

The Roscommon series consists of poorly drained or very poorly drained, rapidly permeable soils on outwash plains. The soils formed in sandy glacial drift material. The slope ranges from 0 to 2 percent.

Roscommon soils commonly are adjacent to AuGres and Tawas soils. AuGres soils have a spodic horizon and are somewhat poorly drained. Tawas soils have an organic layer about 16 to 50 inches thick.

Typical pedon of Roscommon mucky sand, 1,380 feet east and 1,300 feet north of the southwest corner of sec. 36, T. 22 N., R. 6 W.

A—0 to 4 inches; black (10YR 2/1) mucky sand, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; many medium and fine roots; neutral; abrupt smooth boundary.

C1—4 to 14 inches; grayish brown (10YR 5/2) sand; few fine distinct yellowish brown (10YR 5/4) mottles; single grained; loose; common fine roots; mildly alkaline; clear wavy boundary.

C2—14 to 21 inches; brown (10YR 5/3) sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; mildly alkaline; gradual wavy boundary.

Cg—21 to 60 inches; dark gray (10YR 4/1) sand; single grained; loose; mildly alkaline.

Reaction ranges from slightly acid to mildly alkaline. Pebbles range from 0 to 5 percent throughout the pedon.

In cultivated areas, an Ap horizon is 6 to 10 inches thick. It has hue of 10YR, value of 2 or 3 and chroma of 1 or 2. The Ap horizon is sand or loamy sand.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is 4 to 7 inches thick. The A horizon dominantly is mucky sand, but the range includes loamy sand or sand. The C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 1 to 3.

Rubicon Series

The Rubicon series consists of somewhat excessively drained, rapidly permeable soils on outwash plains and moraines. The soils formed in sandy glacial drift material. The slope ranges from 0 to 30 percent.

Rubicon soils are similar to Croswell, East Lake, and Kalkaska soils and commonly are adjacent to Graycalm and Montcalm soils. Croswell soils have mottles in the lower part of the solum. East Lake soils are underlain by calcareous gravelly sand. Kalkaska soils have a more developed spodic horizon than the Rubicon soils. Graycalm and Montcalm soils have an argillic horizon. In addition, Graycalm soils do not have a spodic horizon.

Typical pedon of Rubicon sand, 0 to 6 percent slopes, 400 feet east and 2,100 feet south of the northwest corner of sec. 28, T. 22 N., R. 8 W.

A—0 to 2 inches; very dark gray (10YR 3/1) sand and leaf litter and grains from the E horizon, dark gray (10YR 4/1) dry; very weak fine granular structure; very friable; many coarse roots; very strongly acid; abrupt smooth boundary.

E—2 to 5 inches; grayish brown (10YR 5/2) sand; very weak fine granular structure; very friable; many coarse roots; very strongly acid; abrupt smooth boundary.

Bs—5 to 10 inches; reddish brown (5YR 4/4) sand; very weak fine granular structure; very friable; many fine roots; medium acid; clear wavy boundary.

BC—10 to 24 inches; yellowish brown (10YR 5/6) sand; single grained; loose; many fine roots; medium acid; clear wavy boundary.

C—24 to 60 inches; light yellowish brown (10YR 6/4) sand and some coarse sand; single grained; loose; few fine roots; about 2 percent pebbles; slightly acid.

The solum is 20 to 50 inches thick. Pebbles range from 0 to 5 percent throughout. Reaction ranges from medium acid to very strongly acid.

In cultivated areas, an Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 2. The Ap horizon is 5 to 9 inches thick.

The Bs horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 4 or 6. There are chunks of ortstein in this horizon in some pedons. The BC horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 4 or 6. The C horizon has value of 6 or 7 and chroma of 3 or 4. It ranges from slightly acid to medium acid.

Sims Series

The Sims series consists of poorly drained, slowly permeable soils on till plains. The soils formed in moderately fine textured deposits. The slope ranges from 0 to 2 percent.

Sims soils commonly are adjacent to Iosco, Kawkawlin, and Nester soils. Iosco soils have a spodic horizon and are sandy in the upper part of the solum. Kawkawlin soils have an argillic horizon and are somewhat poorly drained. Nester soils have an argillic horizon and are well drained.

Typical pedon of Sims loam, 300 feet south and 1,500 feet west of the northeast corner of sec. 25, T. 22 N., R. 8 W.

A—0 to 8 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate medium granular structure; friable; many fine roots; slightly acid; abrupt smooth boundary.

Bg1—8 to 14 inches; grayish brown (10YR 5/2) clay loam; few coatings of light brownish gray (10YR 6/2) sand grains on faces of peds; few fine distinct yellowish brown (10YR 5/4) mottles; strong medium subangular blocky structure; firm; few fine roots; slightly acid; clear wavy boundary.

Bg2—14 to 26 inches; grayish brown (10YR 5/2) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; strong coarse subangular blocky structure; firm; neutral; clear wavy boundary.

Cg—26 to 45 inches; grayish brown (10YR 5/2) silty clay loam; common medium distinct yellowish brown (10YR 5/4) mottles and few fine distinct yellowish brown (10YR 5/6) mottles; massive; firm; slight effervescence; mildly alkaline; gradual wavy boundary.

C—45 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; common fine faint yellowish brown (10YR 5/6) mottles; massive; firm; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 20 to 40 inches.

In cultivated areas, an Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1. It is 6 to 9 inches thick.

The A horizon has value of 2 or 3 and chroma of 1. It is 4 to 9 inches thick. The A horizon dominantly is loam, but the range includes silty clay loam or clay loam. The Bg horizon has value of 5 or 6 and chroma of 1 or 2. It is clay loam or silty clay loam. The C horizon has value of 5 to 7 and chroma of 2 to 4.

Tawas Series

The Tawas series consists of very poorly drained soils in depressions on outwash plains and moraines. The soils formed in woody material underlain by sandy mineral material at a depth of 16 to 50 inches. Permeability is moderately slow to moderately rapid in the upper part of the pedon and rapid in the lower part. The slope ranges from 0 to 2 percent.

Tawas soils are similar to Cathro soils and commonly are adjacent to Roscommon soils. Cathro soils are underlain by loamy material at a depth of 16 to 50 inches. Roscommon soils do not have an organic horizon.

Typical pedon of Tawas mucky peat, 2,100 feet east and 250 feet south of the center of sec. 13, T. 22 N., R. 8 W.

Oe—0 to 4 inches; very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed hemic material, very dark grayish brown (10YR 3/2) dry; about 40 percent fibers, about 20 percent rubbed; weak medium granular structure; very friable; primarily herbaceous fibers; many fine roots; strongly acid; abrupt smooth boundary.

Oa1—4 to 10 inches; black (10YR 2/1) broken face and rubbed sapric material; about 25 percent fibers, less than 10 percent rubbed; weak medium granular structure; very friable; primarily woody fibers; few fine roots; few coarse woody fragments; strongly acid; gradual wavy boundary.

Oa2—10 to 22 inches; black (10YR 2/1) broken face and rubbed sapric material; about 10 percent fibers, less than 5 percent rubbed; massive; very friable; primarily woody fibers; few coarse woody fragments; medium acid; clear wavy boundary.

C—22 to 60 inches; grayish brown (10YR 5/2) sand; single grained; loose; mildly alkaline.

The organic layers are 16 to 50 inches thick. In some pedons, the surface tier is sapric material. Reaction in the organic layers ranges from strongly acid to neutral. Reaction in the C horizon ranges from neutral to moderately alkaline.

Plant on [illegible] bottoms, which can include [illegible]

[illegible]

[illegible]

[illegible] Decks [illegible]

[illegible] herbaceous plants and mulching. The [illegible]

[illegible] depth of 18 to 36 inches. Planting [illegible] of [illegible] the upper [illegible]

[illegible]

[illegible]

Formation of the Soils

This section discusses the factors of soil formation, relates them to the formation of soils in the survey area, and explains the processes of soil formation (*3*).

Factors of Soil Formation

Soil forms through the interaction of five major factors: the physical, chemical, and mineral composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or topography; and the length of time that the processes of soil formation have acted on the parent material.

Climate and plant and animal life are the active forces in soil formation. They slowly change the parent material into a natural body of soil that has genetically related layers, called horizons. The effects of climate and plant and animal life are conditioned by relief. The nature of the parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time changes the parent material into a soil. It can be a long time or a short time, but, generally, a long time is required for the formation of distinct soil horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made about the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. The parent material of the soils in Missaukee County was deposited by glaciers or by melt water from the glaciers. Some of this material was subsequently reworked and redeposited by water and wind. The glaciers covered the county about 10,000 to 12,000 years ago. Parent material determines the chemical and mineralogical composition of the soil. Although the parent material is of a common glacial origin, its properties vary greatly, sometimes within a small area, depending on how the material was deposited. The dominant parent materials in Missaukee County were deposited as glacial till, outwash material, alluvium, and organic material.

Glacial till is material that was deposited directly by glaciers with a minimum of water action. It consists of a mixture of particles of different sizes. The small pebbles in glacial till have sharp corners, indicating that they have not been worn by water. The glacial till in Missaukee County generally is calcareous loam, silty clay loam, or clay loam. The Nester soils are an example of soils that formed in glacial till. Typically, they are moderately fine textured or fine textured and have a well developed structure.

Outwash material was deposited by running water from melting glaciers. The size of the particles that make up outwash material depends on the speed of the water that carried them. When the water slows down, the coarser particles are deposited. The finer particles, such as very fine sand, silt, and clay, are carried by slowly moving water. Outwash deposits generally consist of layers of particles of similar size, such as sandy loam, sand, gravel, and other coarse particles. The East Lake soils are an example of soils that formed in outwash material.

Alluvial material has been deposited by floodwater of present streams in recent time. The texture of this material depends on the speed of the water that deposited the material. Fluvaquents is an example of an alluvial soil.

Organic material is made up of plant remains. After the glaciers receded from the areas, water was left standing in depressions on outwash plains, flood plains, moraines, and till plains. Grasses and sedges that grew around the edges of these depressions died. Because of the wetness, when the plants died their remains did not decompose but accumulated around the edge of the depressions. Later, water tolerant trees grew in the areas, and as these trees died, their residue became part of the organic accumulation. Consequently, the depressions were eventually filled with organic material and developed into areas of muck. Lupton soils are an example of soils that formed in organic material.

Plant and Animal Life

Green plants have been the principal organisms influencing the soils in Missaukee County. Bacteria, fungi, earthworms, and man, also have been important. The chief contribution of plant and animal life is the addition of organic matter and nitrogen to the soil. The kind of organic matter on and in the soil depends on the kinds of plants that grew on the soil. The residue of these plants accumulates on the surface of the soil; the residue decays and eventually becomes organic matter. Plant roots provide channels for the downward movement of water through the soil; plant roots add organic matter to the soil as they decay. Bacteria in the soil help to break down the organic matter into a form that can be used by plants.

The vegetation in Missaukee County was a mixture of coniferous and deciduous forest. Differences in natural soil drainage and changes in parent material affect the composition of forest species.

In general, the well drained upland soils, such as Nester and Montcalm soils, were covered with sugar maple and white pine. Rubicon soils were covered with red pine, aspen, and some jack pine. The wet soils were covered with elm, ash, aspen, and white cedar. Roscommon and Brevort soils, which formed under wet conditions, contain a considerable amount of organic matter.

Climate

Climate is important in the formation of soils. It determines the kind of plant and animal life on and in the soil, and it determines the amount of water available for the weathering of minerals and the transporting of soil material. Through its influence on soil temperature, climate determines the rate of chemical reaction in the soil. These climatic influences generally affect areas larger than a county.

The climate in Missaukee County is cool and humid. Presumably it is similar to the climate in which the soils formed. The soils in Missaukee County differ from soils that formed in a dry, warm climate or from those that formed in a moist, hot climate. Climate is uniform throughout the county, but its effect is modified locally by the proximity to large lakes. The minor differences in the soils in Missaukee County are the result of climatic differences.

Relief

Relief, or topography, has had a marked influence on the formation of soils in Missaukee County through its influence on natural drainage, erosion, plant cover, and soil temperature. In this county, slopes range from 0 to 30 percent. Natural soil drainage ranges from excessively drained on the hilltops to very poorly drained in the depressions.

Relief influences the formation of soils by affecting runoff and drainage. Drainage in turn, through its effect on aeration of the soil, determines the color of the soil. Runoff is most rapid on the steeper slopes, but in low areas, water ponds temporarily. Water and air move freely through well drained soils but slowly through very poorly drained soils. In soils that are well aerated, the iron and aluminum compounds that give most soils their color are brightly colored and are oxidized. Poorly aerated soils are dull gray and mottled. Nester soils are examples of well drained, well aerated soils; and Sims soils are examples of poorly drained, poorly aerated soils. Both soils formed in similar parent material.

Time

Generally a long time is required for the development of distinct horizons in a soil from parent material. The differences in the length of time that the parent material has been in place are commonly reflected in the degree of development of the soil profile. Some soils form rapidly; others slowly.

The soils of Missaukee County range from young to mature. The glacial deposits in which many of the soils formed have been exposed to soil-forming factors for a long enough time for distinct horizons to develop. Some soils forming in recent alluvial sediment have not been in place long enough for the development of distinct horizons. Fluvaquents, which formed in alluvial material, are young soils. The Kawkawlin soils are an example of the effect of more time on leaching of lime from the soil.

Processes of Soil Formation

The process responsible for the development of the soil horizons from the unconsolidated parent material is referred to as soil genesis. Soil morphology describes the physical, chemical, and biological properties of these horizons.

Several processes were involved in the development of soil horizons in Missaukee County: (a) accumulation of organic matter, (b) leaching of lime (calcium carbonate) and other bases, (c) reduction and transfer of iron, and (d) formation and translocation of clay minerals. In most soils, more than one of these processes has been active in the development of horizons.

Organic matter accumulates at the surface to form an A1 horizon. If the soil is plowed, the A1 horizon is mixed into a plow layer, or Ap horizon. In the soils of Missaukee County, the surface layer ranges from high to low in organic matter content. For example, Sims soils have a high content of organic matter in the surface layer, and the Rubicon soils have a low organic matter content.

Leaching of carbonates and other bases has occurred in most of the soils. Soil scientists generally agree that leaching of bases in soils generally precedes the translocation of clay minerals. Many of the soils in Missaukee County are moderately leached to strongly leached. For example, Nester soils are leached of carbonates to a depth of 20 to 40 inches, whereas Rubicon soils are leached to a depth of more than 60 inches. This difference in the depth of leaching is a result of time, relief, and parent material.

The reduction and transfer of iron, a process called gleying, is evident in the somewhat poorly drained, poorly drained, and very poorly drained soils. The gray or dull color in the subsoil indicates the reduction and loss of iron. Sims soils are an example of soils in which the gleying processes are evident.

Translocation of clay minerals has contributed to horizon development. An eluviated, or leached, E horizon above an illuviated B horizon has a platy structure, is lower in content of clay, and typically is lighter in color. The E horizon typically has an accumulation of clay and clay films in pores and on the faces of peds. The soils displaying this translocation of clay were probably leached of carbonates and soluable salts to a considerable extent before translocation of clay took place. Leaching of bases and translocation of clay are among the more important processes in horizon differentiation. Nester soils are an example of soils that have translocated clay in the form of clay films accumulated in the B horizon.

In some soils, iron, aluminum, and humus have moved from the surface layer to the B horizon. The color of the B horizon in such soils commonly is dark brown or dark redding brown. The AuGres and Kalkaska soils are examples of soils in which translocated iron, aluminum, and humus have affected the B horizon.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vols., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Jenny, Hans. 1941. Factors of soil formation. 281 pp., illus.

(4) Michigan State University. 1980. Fertilizer recommendations for vegetables and field crops in Michigan. Ext. Bull. E-550, 24 pp.

(5) Mokma, D. L., E. P. Whiteside, and I. F. Schneider. 1978. Soil management units and land use planning. Mich. State Univ. Ext. Bull. E-1262. 12 pp.

(6) Powers, Perry F., assisted by H. G. Cutler. A history of northern Michigan and its people. 555 pp., illus.

(7) Society of American Foresters. 1954. Forest cover types of North America. Rep. Comm. Forest Types, 67 pp.

(8) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(9) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(10) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(11) United States Department of Commerce. 1977. 1974 census of agriculture: Michigan state and county data. Vol. 1 (part 22), 770 pp.

Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting (in tables). Pits caused by melting ground ice. They form on the soil after plant cover is removed.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction

READEX

because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation ar active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-80 at Lake City and Houghton Lake]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have--		Average number of growing degree days*	Average	2 years in 10 will have--		Average number of days with 0.10 inch or more	Average snowfall
				Maximum temperature higher than--	Minimum temperature lower than--			Less than--	More than--		
	°F	°F	°F	°F	°F	Units	In	In	In		In
LAKE CITY:											
January---	25.8	9.1	17.5	46	-22	0	1.26	0.7	1.7	4	19.3
February--	28.8	7.8	18.3	47	-24	0	1.15	.6	.9	4	15.4
March-----	37.9	16.9	27.4	64	-16	1	1.70	.9	2.4	5	12.6
April-----	54.0	30.8	42.4	80	7	44	2.88	1.8	3.8	7	4.4
May-------	67.2	40.5	53.8	86	22	188	2.67	1.5	3.7	7	.2
June------	76.6	49.4	63.0	93	31	400	3.09	1.6	4.4	6	.0
July------	80.9	53.5	67.2	93	37	540	3.26	1.7	4.6	6	.0
August----	78.4	52.2	65.3	92	35	482	3.01	1.4	4.4	6	.0
September-	69.7	45.3	57.5	89	25	253	3.25	1.5	4.7	7	Trace
October---	58.2	36.5	47.4	80	19	81	2.66	1.4	3.8	6	.9
November--	42.7	26.9	34.8	67	0	7	2.33	1.4	3.2	6	9.8
December--	30.3	15.0	22.7	54	-15	0	1.61	1.0	2.2	5	16.0
Year----	54.2	32.0	43.1	95	-26	1,996	28.87	25.7	31.9	69	78.5
HOUGHTON LAKE:											
January---	26.2	9.7	18.0	47	-21	0	1.48	0.8	2.1	5	15.8
February--	29.2	8.5	18.8	48	-25	0	1.19	.6	1.7	4	10.6
March-----	38.8	18.0	28.4	65	-14	2	1.68	.9	2.4	5	9.9
April-----	53.9	31.8	42.8	81	9	47	2.54	1.6	3.4	6	2.6
May-------	67.4	41.7	54.5	88	23	194	2.76	1.6	3.8	7	.1
June------	76.3	50.9	63.6	92	30	430	3.09	1.6	4.4	6	.0
July------	80.3	54.6	67.5	93	36	550	3.26	1.8	4.5	6	.0
August----	78.3	53.2	65.5	92	34	510	2.91	1.6	4.1	6	.0
September-	69.7	46.4	58.0	88	27	273	3.25	1.8	4.6	7	Trace
October---	58.5	37.3	47.9	80	19	108	2.70	1.2	4.0	7	.8
November--	43.1	28.0	35.5	67	2	8	2.37	1.5	3.2	7	7.6
December--	30.6	16.2	23.4	55	-13	0	1.92	1.0	2.7	5	13.0
Year----	54.4	33.0	43.7	95	-26	2,122	29.14	25.4	32.7	70	60.4

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1950-79 at Lake City and Houghton Lake]

Probability	Dates for given probability and temperature		
	24° F or lower	28° F or lower	32° F or lower
LAKE CITY:			
Last freezing temperature in spring:			
1 year in 10 later than--	May 18	May 30	June 17
2 years in 10 later than--	May 12	May 26	June 10
5 years in 10 later than--	Apr. 30	May 16	May 29
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 2	Sept. 14	Aug. 30
2 years in 10 earlier than--	Oct. 9	Sept. 20	Sept. 4
5 years in 10 earlier than--	Oct. 21	Sept. 30	Sept. 14
HOUGHTON LAKE:			
Last freezing temperature in spring:			
1 year in 10 later than--	May 18	June 3	June 16
2 years in 10 later than--	May 11	May 27	June 9
5 years in 10 later than--	Apr. 27	May 14	May 28
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 3	Sept. 15	Aug. 21
2 years in 10 earlier than--	Oct. 10	Sept. 21	Aug. 31
5 years in 10 earlier than--	Oct. 24	Oct. 3	Sept. 17

TABLE 3.--GROWING SEASON

[Recorded in the period 1950-79 at Lake City and Houghton Lake]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
LAKE CITY:			
9 years in 10	151	116	84
8 years in 10	158	123	92
5 years in 10	173	136	108
2 years in 10	188	149	124
1 year in 10	196	156	132
HOUGHTON LAKE:			
9 years in 10	146	113	71
8 years in 10	157	122	85
5 years in 10	179	141	111
2 years in 10	201	160	137
1 year in 10	213	170	151

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
3A	Croswell sand, 0 to 3 percent slopes	11,895	3.3
5B	Emmet-Montcalm complex, 0 to 6 percent slopes	4,760	1.3
5C	Emmet-Montcalm complex, 6 to 12 percent slopes	1,290	0.4
5E	Emmet-Montcalm complex, 12 to 30 percent slopes	1,500	0.4
6B	Kalkaska sand, 0 to 6 percent slopes	3,740	1.0
6C	Kalkaska sand, 6 to 12 percent slopes	3,310	0.9
6E	Kalkaska sand, 12 to 30 percent slopes	2,280	0.6
7	Lupton muck	18,335	5.0
10B	Manistee loamy sand, 0 to 6 percent slopes	8,010	2.2
10C	Manistee loamy sand, 6 to 12 percent slopes	710	0.2
11B	Montcalm-Graycalm complex, 0 to 6 percent slopes	41,095	11.3
11C	Montcalm-Graycalm complex, 6 to 12 percent slopes	9,540	2.6
11E	Montcalm-Graycalm complex, 12 to 30 percent slopes	4,990	1.4
12B	Nester sandy loam, 1 to 6 percent slopes	15,335	4.2
12C	Nester sandy loam, 6 to 12 percent slopes	1,185	0.3
13B	Rubicon sand, 0 to 6 percent slopes	49,585	13.5
13C	Rubicon sand, 6 to 12 percent slopes	20,265	5.5
13E	Rubicon sand, 12 to 30 percent slopes	15,175	4.1
14A	Otisco loamy sand, 0 to 3 percent slopes	9,620	2.6
15B	East Lake-Rubicon sands, 0 to 6 percent slopes	2,180	0.6
15C	East Lake-Rubicon sands, 6 to 12 percent slopes	340	0.1
15E	East Lake-Rubicon sands, 12 to 30 percent slopes	570	0.2
16A	AuGres loamy sand, 0 to 3 percent slopes	11,530	3.2
17	Carbondale muck	2,630	0.7
19B	Grayling sand, 0 to 6 percent slopes	4,170	1.1
20	Tawas mucky peat	15,475	4.2
22	Roscommon mucky sand	16,385	4.5
23A	Kawkawlin Variant sandy loam, 0 to 3 percent slopes	410	0.1
30	Brevort loamy sand	6,320	1.7
34A	Gladwin loamy sand, 0 to 3 percent slopes	480	0.1
36B	Dighton sandy loam, 1 to 6 percent slopes	3,170	0.9
37	Sims loam	5,930	1.6
40A	Iosco loamy sand, 0 to 3 percent slopes	15,645	4.3
42B	Graycalm-Rubicon sands, 0 to 6 percent slopes	14,360	3.9
42C	Graycalm-Rubicon sands, 6 to 12 percent slopes	5,800	1.6
42E	Graycalm-Rubicon sands, 12 to 30 percent slopes	4,420	1.2
46	Loxley mucky peat	2,610	0.7
50A	Kawkawlin loam, 0 to 3 percent slopes	17,935	4.9
53	Cathro muck	3,060	0.8
64	Fluvaquents and Histosols, frequently flooded	3,300	0.9
65	Pits, sand and gravel	340	0.1
66	Udipsamments, nearly level	230	0.1
	Water	6,170	1.7
	Total	366,080	100.0

TABLE 5.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Land capability	Corn	Corn silage	Oats	Winter wheat	Grass-legume hay	Grass hay
		Bu	Tons	Bu	Bu	Tons	Tons
3A-------------- Croswell	IVs	50	8	40	25	2.5	0.8
5B-------------- Emmet-Montcalm	IIe	75	14	63	34	3.4	1.5
5C-------------- Emmet-Montcalm	IVe	68	13	58	31	3.3	1.4
5E-------------- Emmet-Montcalm	VIe	---	---	---	---	---	---
6B-------------- Kalkaska	IVs	45	7	35	18	1.8	0.5
6C-------------- Kalkaska	VIs	---	---	---	---	1.6	0.4
6E-------------- Kalkaska	VIIs	---	---	---	---	---	---
7--------------- Lupton	Vw	---	---	---	---	---	---
10B------------- Manistee	IIIs	70	13	70	35	3.5	1.6
10C------------- Manistee	IIIe	65	12	65	30	3.2	1.3
11B------------- Montcalm-Graycalm	IIIs	63	12	53	28	2.9	1.1
11C------------- Montcalm-Graycalm	IVs	---	---	---	---	2.7	1.0
11E------------- Montcalm-Graycalm	VIs	---	---	---	---	---	---
12B------------- Nester	IIe	80	14	75	40	3.3	1.4
12C------------- Nester	IIIe	70	13	70	36	3.1	1.3
13B, 13C-------- Rubicon	VIs	---	---	---	---	2.7	1.0
13E------------- Rubicon	VIIs	---	---	---	---	---	---
14A------------- Otisco	IIIw	70	13	65	30	3.5	1.6
15B------------- East Lake-Rubicon	IVs	40	6	32	20	1.8	0.5
15C------------- East Lake-Rubicon	VIs	---	---	---	---	---	---

TABLE 5.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Oats	Winter wheat	Grass-legume hay	Grass hay
		Bu	Tons	Bu	Bu	Tons	Tons
15E-------------- East Lake-Rubicon	VIIs	---	---	---	---	---	---
16A-------------- AuGres	IVw	50	10	45	25	2.2	0.6
17--------------- Carbondale	Vw	---	---	---	---	---	---
19B-------------- Grayling	VIs	---	---	---	---	---	---
20--------------- Tawas	VIw	---	---	---	---	---	---
22--------------- Roscommon	VIw	---	---	---	---	---	---
23A-------------- Kawkawlin Variant	IIw	85	16	80	42	3.6	1.7
30--------------- Brevort	Vw	---	---	---	---	---	---
34A-------------- Gladwin	IIIw	60	12	60	27	2.8	1.0
36B-------------- Dighton	IIe	90	16	80	45	3.9	1.9
37--------------- Sims	Vw	---	---	---	---	---	---
40A-------------- Iosco	IIIw	80	15	75	40	3.5	1.6
42B-------------- Graycalm-Rubicon	IVs	45	9	35	20	2.3	0.7
42C-------------- Graycalm-Rubicon	VIs	---	---	---	---	2.0	0.5
42E-------------- Graycalm-Rubicon	VIIs	---	---	---	---	---	---
46--------------- Loxley	VIIw	---	---	---	---	---	---
50A-------------- Kawkawlin	IIw	85	16	80	42	3.6	1.7
53--------------- Cathro	VIIw	---	---	---	---	---	---
64--------------- Fluvaquents and Histosols	---	---	---	---	---	---	---
65. Pits							
66. Udipsamments							

TABLE 6.--CAPABILITY CLASSES AND SUBCLASSES

[Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)		
		Erosion (e)	Wetness (w)	Soil problem (s)
		Acres	Acres	Acres
I	---	---	---	---
II	41,610	23,265	18,345	---
III	76,745	1,895	25,745	49,105
IV	54,535	1,290	11,530	41,715
V	33,215	---	33,215	---
VI	121,820	1,500	31,860	88,460
VII	28,115	---	5,670	22,445
VIII	---	---	---	---

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
3A----------------- Croswell	2s	Slight	Moderate	Moderate	Slight	Quaking aspen-------	68	Red pine, eastern white pine, Carolina poplar.
						Red pine------------	55	
						Jack pine-----------	53	
						Northern red oak----	---	
						Eastern white pine--	---	
						Red maple-----------	---	
						Paper birch---------	---	
						White spruce--------	---	
						Balsam fir----------	---	
5B*, 5C*: Emmet--------------	2o	Slight	Slight	Slight	Slight	Quaking aspen-------	66	Carolina poplar, red pine, eastern white pine.
						Sugar maple---------	---	
						Yellow birch--------	---	
						Red pine------------	---	
						American basswood---	---	
						American beech------	---	
						Eastern white pine--	---	
						Northern red oak----	---	
Montcalm-----------	2s	Slight	Slight	Moderate	Slight	Sugar maple---------	61	Red pine, eastern white pine, Carolina poplar.
						Yellow birch--------	---	
						Northern red oak----	66	
						Eastern white pine--	---	
						Red pine------------	---	
						Red maple-----------	---	
						Bigtooth aspen------	---	
						Paper birch---------	---	
5E*: Emmet--------------	2r	Moderate	Moderate	Slight	Slight	Quaking aspen-------	66	Carolina poplar, red pine, eastern white pine.
						Sugar maple---------	---	
						Yellow birch--------	---	
						Red pine------------	---	
						American basswood---	---	
						American beech------	---	
						Eastern white pine--	---	
						Northern red oak----	---	
Montcalm-----------	2r	Moderate	Moderate	Moderate	Slight	Sugar maple---------	61	Red pine, eastern white pine, Carolina poplar.
						Yellow birch--------	---	
						Northern red oak----	66	
						Eastern white pine--	---	
						Red pine------------	---	
						Red maple-----------	---	
						Paper birch---------	---	
						Bigtooth aspen------	---	
6B, 6C------------- Kalkaska	2s	Slight	Slight	Moderate	Slight	Sugar maple---------	62	Red pine, Carolina poplar, eastern white pine.
						Quaking aspen-------	---	
						Red pine------------	---	
						Eastern white pine--	---	
						American beech------	---	
						Paper birch---------	---	
						Northern red oak----	---	
6E----------------- Kalkaska	2r	Moderate	Moderate	Moderate	Slight	Sugar maple---------	62	Red pine, Carolina poplar, eastern white pine.
						Quaking aspen-------	---	
						Red pine------------	---	
						Eastern white pine--	---	
						American beech------	---	
						Paper birch---------	---	
						Northern red oak----	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
7 Lupton	4w	Slight	Severe	Severe	Severe	Black spruce	20	
						Balsam fir	46	
						Black ash	---	
						Northern white-cedar	---	
						Paper birch	---	
						Tamarack	---	
						Quaking aspen	---	
10B, 10C Manistee	2s	Slight	Slight	Moderate	Slight	Sugar maple	61	Red pine, eastern white pine, Carolina poplar.
						Eastern white pine	---	
						Red maple	---	
						Red pine	---	
						Eastern hemlock	---	
						Northern red oak	---	
						White ash	---	
						Yellow birch	---	
						American beech	---	
11B*, 11C*:								
Montcalm	2s	Slight	Slight	Moderate	Slight	Sugar maple	61	Red pine, eastern white pine, Carolina poplar, Norway spruce.
						Yellow birch	---	
						Northern red oak	66	
						Eastern white pine	---	
						Red pine	---	
						Paper birch	---	
						Red maple	---	
						Bigtooth aspen	---	
Graycalm	2s	Slight	Moderate	Severe	Slight	Bigtooth aspen	70	Red pine, eastern white pine, Carolina poplar, white spruce.
						Northern red oak	---	
						Jack pine	56	
						Red pine	64	
						Paper birch	---	
						Eastern white pine	---	
						American beech	---	
						Red maple	---	
						Sugar maple	---	
11E*:								
Montcalm	2r	Moderate	Moderate	Moderate	Slight	Sugar maple	61	Red pine, eastern white pine, Carolina poplar, Norway spruce.
						Yellow birch	---	
						Northern red oak	66	
						Eastern white pine	---	
						Red pine	---	
						Paper birch	---	
						Red maple	---	
						Bigtooth aspen	---	
Graycalm	2r	Moderate	Moderate	Severe	Slight	Bigtooth aspen	70	Red pine, eastern white pine, Carolina poplar, white spruce.
						Northern red oak	---	
						Jack pine	56	
						Red pine	64	
						Paper birch	---	
						Eastern white pine	---	
						American beech	---	
						Red maple	---	
						Sugar maple	---	
12B, 12C Nester	2o	Slight	Slight	Slight	Slight	Sugar maple	61	White spruce, red pine, Norway spruce, eastern white pine, Carolina poplar.
						Quaking aspen	---	
						White ash	---	
						American basswood	---	
						Northern red oak	---	
						White oak	---	
						Black cherry	---	
						Yellow birch	---	
						American beach	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
13B, 13C----------- Rubicon	3s	Slight	Moderate	Severe	Slight	Red pine------------	50	Red pine, eastern white pine, jack pine.
						Bigtooth aspen------	---	
						Balsam fir----------	---	
						Jack pine-----------	48	
						Northern red oak----	---	
						Quaking aspen-------	---	
						Red maple-----------	---	
						Paper birch---------	---	
						Eastern white pine--	45	
13E--------------- Rubicon	3r	Moderate	Moderate	Severe	Slight	Red pine------------	50	Red pine, eastern white pine, jack pine.
						Bigtooth aspen------	---	
						Balsam fir----------	---	
						Jack pine-----------	48	
						Northern red oak----	---	
						Quaking aspen-------	---	
						Red maple-----------	---	
						Paper birch---------	---	
						Eastern white pine--	45	
14A--------------- Otisco	3w	Slight	Moderate	Slight	Moderate	Quaking aspen-------	60	White spruce, Carolina poplar, eastern white pine, northern white-cedar.
						Yellow birch--------	---	
						Balsam fir----------	---	
						White spruce--------	---	
						White ash-----------	---	
						Black spruce--------	---	
						Red maple-----------	---	
						Paper birch---------	---	
15B*, 15C*:								
East Lake---------	3s	Slight	Slight	Severe	Slight	Sugar maple---------	53	Red pine, white spruce, jack pine.
						Northern red oak----	---	
						Quaking aspen-------	---	
						Red pine------------	55	
						Jack pine-----------	---	
						Paper birch---------	---	
Rubicon-----------	3s	Slight	Moderate	Severe	Slight	Red pine------------	50	Red pine, eastern white pine, jack pine.
						Bigtooth aspen------	---	
						Balsam fir----------	---	
						Jack pine-----------	48	
						Northern red oak----	---	
						Quaking aspen-------	---	
						Red maple-----------	---	
						Paper birch---------	---	
						Eastern white pine--	45	
15E*:								
East Lake---------	3r	Moderate	Severe	Severe	Slight	Sugar maple---------	53	Red pine, white spruce, jack pine.
						Northern red oak----	---	
						Quaking aspen-------	---	
						Red pine------------	55	
						Jack pine-----------	---	
						Paper birch---------	---	
Rubicon-----------	3r	Moderate	Moderate	Severe	Slight	Red pine------------	50	Red pine, eastern white pine, jack pine.
						Bigtooth aspen------	---	
						Balsam fir----------	---	
						Jack pine-----------	48	
						Northern red oak----	---	
						Quaking aspen-------	---	
						Red maple-----------	---	
						Paper birch---------	---	
						Eastern white pine--	45	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
16A AuGres	2w	Slight	Moderate	Slight	Slight	Quaking aspen	70	White spruce, Caroli poplar, eastern whi pine, northern whit cedar.
						Bigtooth aspen	---	
						Balsam fir	---	
						Paper birch	---	
						Yellow birch	---	
						Red maple	---	
						Eastern white pine	---	
						Northern white-cedar	---	
						White spruce	---	
17 Carbondale	5w	Slight	Severe	Severe	Severe	Black spruce	14	
						Balsam fir	---	
						Northern white-cedar	---	
						Tamarack	---	
						Paper birch	---	
19B Grayling	4s	Slight	Slight	Severe	Slight	Jack pine	48	Jack pine, red pine.
						Northern pin oak	43	
						White oak	---	
						Red pine	---	
						Quaking aspen	---	
20 Tawas	5w	Slight	Severe	Severe	Severe	Balsam fir	40	
						Northern white-cedar	---	
						Quaking aspen	---	
						Black ash	---	
						Red maple	---	
22 Roscommon	3w	Slight	Severe	Severe	Moderate	Quaking aspen	58	Eastern white pine, white spruce.
						Black spruce	---	
						Northern white-cedar	---	
						Jack pine	---	
						Silver maple	---	
						Red maple	---	
						Yellow birch	---	
						Balsam fir	---	
						Eastern hemlock	---	
23A Kawkawlin Variant	2w	Slight	Moderate	Slight	Slight	Sugar maple	61	White spruce, easter white pine.
						Northern red oak	---	
						Quaking aspen	---	
						American basswood	---	
						Paper birch	---	
						Red maple	---	
30 Brevort	5w	Slight	Severe	Severe	Severe	Quaking aspen	40	
						Balsam fir	---	
						Northern white-cedar	---	
						American basswood	---	
						Red maple	---	
						Black spruce	15	
34A Gladwin	3w	Slight	Moderate	Slight	Slight	Quaking aspen	60	White spruce, easter white pine, norther white-cedar.
						Sugar maple	53	
						Eastern hemlock	---	
						Eastern white pine	53	
						Red maple	56	
						Bigtooth aspen	60	
						Balsam fir	53	
						Paper birch	55	
						White spruce	53	
36B Dighton	2o	Slight	Slight	Slight	Slight	Sugar maple	64	White spruce, red pine, Carolina poplar, eastern white pine.
						Quaking aspen	---	
						White ash	---	
						Black cherry	---	
						American basswood	---	
						Northern red oak	---	
						Yellow birch	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
37 Sims	4w	Slight	Severe	Moderate	Moderate	Red maple	45	
						White ash	---	
						American basswood	---	
						Black spruce	---	
						Quaking aspen	---	
						Northern white-cedar	---	
						Balsam fir	---	
						Bigtooth aspen	---	
40A Iosco	3w	Slight	Moderate	Slight	Moderate	Quaking aspen	60	White spruce, Carolina poplar, eastern white pine, northern white-cedar.
						White ash	---	
						Red maple	---	
						Yellow birch	---	
						Northern pin oak	---	
						Eastern white pine	---	
						Paper birch	---	
						White spruce	---	
						Balsam fir	---	
42B*, 42C*:								
Graycalm	2s	Slight	Moderate	Severe	Slight	Bigtooth aspen	70	Red pine, eastern white pine, Carolina poplar, white spruce.
						Northern red oak	---	
						Jack pine	56	
						Red pine	64	
						Paper birch	---	
						Eastern white pine	---	
						American beech	---	
						Red maple	---	
Rubicon	3s	Slight	Moderate	Severe	Slight	Red pine	50	Red pine, eastern white pine, jack pine.
						Bigtooth aspen	---	
						Balsam fir	---	
						Jack pine	48	
						Northern red oak	---	
						Quaking aspen	---	
						Red maple	---	
						Paper birch	---	
						Eastern white pine	45	
42E*:								
Graycalm	2r	Moderate	Moderate	Severe	Slight	Bigtooth aspen	70	Red pine, eastern white pine, Carolina poplar, white spruce.
						Northern red oak	---	
						Jack pine	56	
						Red pine	64	
						Paper birch	---	
						Eastern white pine	---	
						American beech	---	
						Red maple	---	
Rubicon	3r	Moderate	Moderate	Severe	Slight	Red pine	50	Red pine, eastern white pine, jack pine.
						Bigtooth aspen	---	
						Balsam fir	---	
						Jack pine	48	
						Northern red oak	---	
						Quaking aspen	---	
						Red maple	---	
						Paper birch	---	
						Eastern white pine	45	
50A Kawkawlin	2w	Slight	Moderate	Slight	Slight	Sugar maple	61	White spruce, red pine, eastern white pine, Carolina poplar.
						Northern red oak	---	
						Balsam fir	---	
						Red maple	---	
						White ash	---	
						American basswood	---	
						Bigtooth aspen	---	
						White spruce	---	
						Paper birch	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	
53 Cathro	5w	Slight	Severe	Severe	Severe	Balsam fir Northern white-cedar Tamarack American basswood Red maple Black spruce	40 15 35 40 40 15	

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
3A Croswell	Manyflower cotoneaster.	Lilac, silky dogwood, Amur maple, white spruce, Amur privet.	Austrian pine, eastern redcedar, Siberian crabapple.	Red pine, eastern white pine.	Carolina poplar.
5B*, 5C*, 5E*: Emmet	---	Arrowwood, lilac, Siberian crabapple, Tatarian honeysuckle, Amur privet.	White spruce, eastern redcedar.	Red pine, Norway spruce, eastern white pine, Austrian pine.	Carolina poplar.
Montcalm	---	Amur maple, Siberian peashrub, lilac, silky dogwood, Amur privet.	White spruce, Siberian crabapple, northern white-cedar.	Red pine, Norway spruce, eastern white pine, jack pine.	---
6B, 6C, 6E Kalkaska	Manyflower cotoneaster.	Lilac, Amur maple, Amur privet, Siberian peashrub, Siberian crabapple, silky dogwood.	Eastern redcedar	Red pine, eastern white pine, Austrian pine.	Carolina poplar.
7. Lupton					
10B, 10C Manistee	---	Siberian crabapple, silky dogwood, Tatarian honeysuckle, lilac, Amur privet, American cranberrybush.	White spruce, eastern redcedar.	Red pine, Norway spruce, Austrian pine, eastern white pine.	---
11B*, 11C*, 11E*: Montcalm	---	Amur maple, Siberian peashrub, lilac, silky dogwood, Amur privet.	White spruce, Siberian crabapple, northern white-cedar.	Red pine, Norway spruce, eastern white pine, jack pine.	---
Graycalm	Vanhoutte spirea, manyflower cotoneaster.	Siberian peashrub, lilac, Amur privet, Amur maple.	Eastern redcedar, Siberian crabapple.	Red pine, Austrian pine, eastern white pine.	Carolina poplar.
12B, 12C Nester	---	Arrowwood, lilac, Tatarian honeysuckle, white spruce, Amur privet, silky dogwood.	Blue spruce	Red pine, green ash, Austrian pine, eastern white pine.	Carolina poplar.
13B, 13C, 13E Rubicon	Vanhoutte spirea, manyflower cotoneaster.	Eastern redcedar, Amur privet, lilac, hawthorn, Siberian peashrub, Amur maple.	Austrian pine	Red pine, eastern white pine, jack pine.	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
14A Otisco	---	American cranberrybush, silky dogwood, Tatarian honeysuckle, white spruce, Amur privet, nannyberry viburnum.	Northern white-cedar, Manchurian crabapple.	Green ash, Norway spruce, eastern white pine.	Carolina poplar.
15B*, 15C*, 15E*: East Lake	---	Siberian peashrub, lilac, Tatarian honeysuckle, Amur privet.	Eastern redcedar, Austrian pine, Siberian crabapple.	Red pine	---
Rubicon	Vanhoutte spirea, manyflower cotoneaster.	Eastern redcedar, Amur privet, lilac, hawthorn, Siberian peashrub, Amur maple.	Austrian pine	Red pine, eastern white pine, jack pine.	---
16A AuGres	---	Silky dogwood, American cranberrybush, Amur maple, common ninebark, nannyberry viburnum.	White spruce, northern white-cedar, Manchurian crabapple.	Norway spruce, green ash, eastern white pine.	Carolina poplar.
17. Carbondale					
19B Grayling	Vanhoutte spirea	Lilac, Siberian peashrub, Amur privet, eastern redcedar, Tatarian honeysuckle.	Jack pine, eastern white pine, Austrian pine.	Red pine	---
20. Tawas					
22. Roscommon					
23A Kawkawlin Variant	---	Northern white-cedar, Amur maple, lilac, silky dogwood, common ninebark.	White spruce, Norway spruce, Black Hills spruce.	Green ash, eastern white pine, red maple.	---
30. Brevort					
34A Gladwin	---	Lilac, American cranberrybush, nannyberry viburnum, Roselow sargent crabapple, Amur maple, silky dogwood.	White spruce, northern white-cedar, Manchurian crabapple.	Eastern white pine, green ash.	Carolina poplar.
36B Dighton	---	Silky dogwood, Amur maple, lilac, Amur privet, Siberian peashrub.	Black Hills spruce, Siberian crabapple, northern white-cedar.	Green ash, Norway spruce, red pine, eastern white pine.	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
37. Sims					
40A Iosco	---	White spruce, American cranberrybush, Amur privet, Tatarian honeysuckle, silky dogwood.	Northern white-cedar, Manchurian crabapple.	Golden willow, green ash, eastern white pine, Norway spruce.	Carolina poplar.
42B*, 42C*, 42E*: Graycalm	Vanhoutte spirea, manyflower cotoneaster.	Siberian peashrub, lilac, Amur privet, Amur maple.	Eastern redcedar, Siberian crabapple.	Red pine, Austrian pine, eastern white pine.	Carolina poplar.
Rubicon	Vanhoutte spirea, manyflower cotoneaster.	Eastern redcedar, Amur privet, lilac, hawthorn, Siberian peashrub, Amur maple.	Austrian pine	Red pine, eastern white pine, jack pine.	---
46 Loxley	Common ninebark	Tatarian honeysuckle.	---	White willow, golden willow.	Imperial Carolina poplar.
50A Kawkawlin	Vanhoutte spirea	White spruce, Roselow sargent crabapple, silky dogwood, Amur maple, lilac, American cranberrybush, nannyberry viburnum, northern white-cedar.	---	Red pine, Norway spruce, eastern white pine.	---
53. Cathro					
64*: Fluvaquents.					
Histosols.					
65*. Pits					
66*. Udipsamments					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
3A Croswell	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Moderate: droughty, too sandy.
5B*: Emmet	Slight	Slight	Moderate: slope.	Slight	Slight.
Montcalm	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
5C*: Emmet	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Montcalm	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
5E*: Emmet	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Montcalm	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
6B Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
6C Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty.
6E Kalkaska	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty, slope.
7 Lupton	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
10B Manistee	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
10C Manistee	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
11B*: Montcalm	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
Graycalm	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
11C*: Montcalm	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
11C*:					
Graycalm	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty.
11E*:					
Montcalm	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Graycalm	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty, slope.
12B Nester	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
12C Nester	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
13B Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
13C Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty.
13E Rubicon	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty, slope.
14A Otisco	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
15B*:					
East Lake	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Moderate: droughty, too sandy.
Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
15C*:					
East Lake	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Moderate: droughty, slope.
Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty.
15E*:					
East Lake	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: slope.
Rubicon	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty, slope.
16A AuGres	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
17 Carbondale	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
19B Grayling	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
20 Tawas	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
22 Roscommon	Severe: ponding, too sandy.	Severe: ponding, too sandy.	Severe: too sandy, ponding.	Severe: ponding, too sandy.	Severe: ponding.
23A Kawkawlin Variant	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
30 Brevort	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
34A Gladwin	Severe: wetness.	Severe: wetness.	Severe: small stones, wetness.	Severe: wetness.	Severe: wetness.
36B Dighton	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
37 Sims	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
40A Iosco	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
42B*:					
Graycalm	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
42C*:					
Graycalm	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty.
Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty.
42E*:					
Graycalm	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty, slope.
Rubicon	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty, slope.
46 Loxley	Severe: ponding, excess humus, too acid.	Severe: ponding, excess humus, too acid.	Severe: excess humus, ponding, too acid.	Severe: ponding, excess humus.	Severe: too acid, ponding, excess humus.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
50A-------------------- Kawkawlin	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
53-------------------- Cathro	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
64*:					
Fluvaquents.					
Histosols.					
65*. Pits					
66*. Udipsamments					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that th
soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlif
3A Croswell	Poor	Poor	Fair	Good	Good	Poor	Very poor.	Poor	Fair	Very poor.
5B*:										
Emmet	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Montcalm	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
5C*:										
Emmet	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Montcalm	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
5E*:										
Emmet	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Montcalm	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
6B, 6C, 6E Kalkaska	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
7 Lupton	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
10B Manistee	Fair	Poor	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
10C Manistee	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
11B*, 11C*:										
Montcalm	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Graycalm	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
11E*:										
Montcalm	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Graycalm	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
12B Nester	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
12C Nester	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
13B Rubicon	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
13C, 13E Rubicon	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
14A----------------- Otisco	Poor	Fair	Good	Fair	Fair	Fair	Very poor.	Fair	Good	Very poor.
15B*: East Lake----------	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
Rubicon------------	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
15C*: East Lake----------	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Rubicon------------	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
15E*: East Lake----------	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Rubicon------------	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
16A----------------- AuGres	Poor	Poor	Fair	Good	Good	Poor	Very poor.	Poor	Fair	Very poor.
17------------------ Carbondale	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
19B----------------- Grayling	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Poor	Poor	Very poor.
20------------------ Tawas	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
22------------------ Roscommon	Very poor.	Poor	Poor	Fair	Fair	Good	Good	Poor	Fair	Good.
23A----------------- Kawkawlin Variant	Fair	Good	Good	Good	Good	Good	Fair	Good	Good	Fair.
30------------------ Brevort	Poor	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Poor.
34A----------------- Gladwin	Poor	Fair	Fair	Fair	Fair	Fair	Very poor.	Fair	Fair	Very poor.
36B----------------- Dighton	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
37------------------ Sims	Poor	Fair	Fair	Good	Good	Good	Good	Fair	Good	Good.
40A----------------- Iosco	Poor	Fair	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
42B*: Graycalm-----------	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
Rubicon------------	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
42C*, 42E*:										
Graycalm	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
Rubicon	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
46 Loxley	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
50A Kawkawlin	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Fair.
53 Cathro	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
64*:										
Fluvaquents.										
Histosols.										
65*. Pits										
66*. Udipsamments										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
3A Croswell	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: droughty, too sandy.
5B*:						
Emmet	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
Montcalm	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
5C*:						
Emmet	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Montcalm	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
5E*:						
Emmet	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Montcalm	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
6B Kalkaska	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
6C Kalkaska	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
6E Kalkaska	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
7 Lupton	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
10B Manistee	Severe: cutbanks cave.	Slight	Severe: shrink-swell.	Slight	Slight	Moderate: droughty.
10C Manistee	Severe: cutbanks cave.	Moderate: slope.	Severe: shrink-swell.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
11B*:						
Montcalm	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
Graycalm	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
11C*:						
Montcalm	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Graycalm	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
11E*:						
Montcalm	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Graycalm	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
12B Nester	Moderate: too clayey, dense layer.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
12C Nester	Moderate: too clayey, dense layer, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
13B Rubicon	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
13C Rubicon	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
13E Rubicon	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
14A Otisco	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
15B*:						
East Lake	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty, too sandy.
Rubicon	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
15C*:						
East Lake	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Rubicon	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
15E*:						
East Lake	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Rubicon	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
16A AuGres	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
17 Carbondale	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
19B Grayling	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
20 Tawas	Severe: cutbanks cave, excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, excess humus.
22 Roscommon	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
23A Kawkawlin Variant	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
30 Brevort	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
34A Gladwin	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
36B Dighton	Severe: cutbanks cave.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: low strength.	Moderate: droughty.
37 Sims	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
40A Iosco	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
42B*: Graycalm	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
Rubicon	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
42C*: Graycalm	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
Rubicon	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
42E*: Graycalm	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
Rubicon	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
46 Loxley	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: too acid, ponding, excess humus.
50A Kawkawlin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
53 Cathro	Severe: excess humus, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding, excess humus
64*: Fluvaquents.						
Histosols.						
65*. Pits						
66*. Udipsamments						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
3A Croswell	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
5B: Emmet	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Montcalm	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
5C: Emmet	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
Montcalm	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
5E: Emmet	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Montcalm	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
6B Kalkaska	Severe:* poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
6C Kalkaska	Severe:* poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
6E Kalkaska	Severe:* poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
7 Lupton	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
10B Manistee	Severe: percs slowly.	Severe: seepage.	Severe: too clayey.	Severe: seepage.	Poor: too clayey, hard to pack.
10C Manistee	Severe: percs slowly.	Severe: seepage, slope.	Severe: too clayey.	Severe: seepage.	Poor: too clayey, hard to pack.
11B: Montcalm	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
11B:					
Graycalm	Severe:* poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
11C:					
Montcalm	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Graycalm	Severe:* poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
11E:					
Montcalm	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
Graycalm	Severe:* poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
12B Nester	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
12C Nester	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
13B Rubicon	Severe:* poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
13C Rubicon	Severe:* poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
13E Rubicon	Severe:* poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
14A Otisco	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
15B:					
East Lake	Severe:* poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Rubicon	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
15C:					
East Lake	Severe:* poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
15C: Rubicon	Severe:* poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
15E: East Lake	Severe:* poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Rubicon	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
16A AuGres	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
17 Carbondale	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
19B Grayling	Severe:* poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
20. Tawas					
22 Roscommon	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
23A Kawkawlin Variant	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
30 Brevort	Severe: ponding, percs slowly, poor filter.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
34A Gladwin	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
36B Dighton	Severe: percs slowly, poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
37 Sims	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
40A Iosco	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
42B:					
Graycalm	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Rubicon	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
42C:					
Graycalm	Severe:* poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Rubicon	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
42E:					
Graycalm	Severe:* poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
Rubicon	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
46 Loxley	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus, too acid.
50A Kawkawlin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
53 Cathro	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
64:					
Fluvaquents.					
Histosols.					
65. Pits					
66. Udipsamments					

* The effluent drains satisfactorily, but there is a danger of ground water pollution.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
3A Croswell	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
5B*: Emmet	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Montcalm	Good	Probable	Improbable: too sandy.	Poor: thin layer.
5C*: Emmet	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
Montcalm	Good	Probable	Improbable: too sandy.	Poor: thin layer.
5E*: Emmet	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Montcalm	Fair: slope.	Probable	Improbable: too sandy.	Poor: thin layer, slope.
6B, 6C Kalkaska	Good	Probable	Improbable: too sandy.	Poor: too sandy.
6E Kalkaska	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
7 Lupton	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
10B Manistee	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy.
10C Manistee	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, too sandy.
11B*, 11C*: Montcalm	Good	Probable	Improbable: too sandy.	Poor: thin layer.
Graycalm	Good	Probable	Improbable: too sandy.	Poor: too sandy.
11E*: Montcalm	Fair: slope.	Probable	Improbable: too sandy.	Poor: thin layer, slope.
Graycalm	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
12B, 12C Nester	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
13B, 13C Rubicon	Good	Probable	Improbable: too sandy.	Poor: too sandy.
13E Rubicon	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
14A Otisco	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
15B*, 15C*:				
East Lake	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
Rubicon	Good	Probable	Improbable: too sandy.	Poor: too sandy.
15E*:				
East Lake	Fair: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
Rubicon	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
16A AuGres	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
17 Carbondale	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
19B Grayling	Good	Probable	Improbable: too sandy.	Poor: too sandy.
20 Tawas	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
22 Roscommon	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
23A Kawkawlin Variant	Fair: wetness.	Probable	Improbable: too sandy.	Poor: thin layer.
30 Brevort	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
34A Gladwin	Poor: wetness.	Probable	Probable	Poor: small stones, area reclaim.
36B Dighton	Good	Probable	Probable	Poor: area reclaim.
37 Sims	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
40A Iosco	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
42B*, 42C*: Graycalm	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Rubicon	Good	Probable	Improbable: too sandy.	Poor: too sandy.
42E*: Graycalm	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
Rubicon	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
46 Loxley	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness, too acid.
50A Kawkawlin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
53 Cathro	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
64*: Fluvaquents.				
Histosols.				
65*. Pits				
66*. Udipsamments				

---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
3A Croswell	Severe: seepage.	Severe: seepage.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Droughty.
5B*:						
Emmet	Severe: seepage.	Moderate: seepage.	Severe: no water.	Deep to water	Soil blowing, slope.	Favorable.
Montcalm	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
5C*, 5E*:						
Emmet	Severe: seepage, slope.	Moderate: seepage.	Severe: no water.	Deep to water	Soil blowing, slope.	Slope.
Montcalm	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
6B Kalkaska	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
6C, 6E Kalkaska	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
7 Lupton	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
10B Manistee	Severe: seepage.	Severe: hard to pack.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty, percs slowly.
10C Manistee	Severe: seepage, slope.	Severe: hard to pack.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty, percs slowly.
11B*:						
Montcalm	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
Graycalm	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
11C*, 11E*:						
Montcalm	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
Graycalm	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
12B Nester	Moderate: slope.	Slight	Severe: no water.	Deep to water	Slope	Favorable.
12C Nester	Severe: slope.	Slight	Severe: no water.	Deep to water	Slope	Slope.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
13B Rubicon	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
13C, 13E Rubicon	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
14A Otisco	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
15B*:						
East Lake	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
Rubicon	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
15C*, 15E*:						
East Lake	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
Rubicon	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
16A AuGres	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
17 Carbondale	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
19B Grayling	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
20 Tawas	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: slow refill, cutbanks cave.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
22 Roscommon	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Wetness, droughty.
23A Kawkawlin Variant	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: slow refill, cutbanks cave.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness.
30 Brevort	Severe: seepage.	Severe: piping, ponding.	Severe: slow refill, cutbanks cave.	Ponding, frost action.	Ponding, droughty, fast intake.	Wetness, droughty.
34A Gladwin	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
36B Dighton	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, soil blowing.	Droughty.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
37 Sims	Slight	Severe: ponding.	Severe: slow refill.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Wetness, percs slowly.
40A Iosco	Severe: seepage.	Severe: piping, wetness.	Severe: slow refill, cutbanks cave.	Favorable	Wetness, droughty, fast intake.	Wetness, erodes easily, droughty.
42B*: Graycalm	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
Rubicon	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
42C*, 42E*: Graycalm	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
Rubicon	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
46 Loxley	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing, too acid.	Not needed.
50A Kawkawlin	Slight	Severe: wetness.	Severe: slow refill.	Frost action	Wetness	Wetness.
53 Cathro	Severe: seepage.	Severe: piping, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
64*: Fluvaquents.						
Histosols.						
65*. Pits						
66*. Udipsamments						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
3A---------------- Croswell	0-7	Sand--------------	SP-SM, SM	A-3, A-2-4	0	90-100	85-100	50-70	5-25	---	NP
	7-31	Sand, loamy sand	SP-SM, SM	A-3, A-2-4	0	90-100	85-100	50-70	5-25	---	NP
	31-60	Sand--------------	SP-SM, SM	A-3, A-2-4	0	90-100	85-100	50-70	5-25	---	NP
5B*, 5C*, 5E*: Emmet------------	0-9	Sandy loam--------	SM, SM-SC, SC	A-2	0-5	95-100	95-100	55-70	25-35	10-25	NP-10
	9-22	Sandy loam, loamy sand, fine sandy loam.	SM, SM-SC, SC	A-2	0-5	95-100	90-100	55-70	15-35	10-25	NP-10
	22-43	Loam, sandy loam, sandy clay loam.	SM-SC, CL, CL-ML, SC	A-2, A-4, A-6	0-5	95-100	90-100	55-85	25-75	20-40	5-20
	43-60	Sandy loam, fine sandy loam.	SM, SM-SC, SC	A-2	0-5	85-95	80-90	50-70	25-35	<25	NP-10
Montcalm---------	0-7	Loamy sand--------	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	7-30	Loamy sand, sand	SM	A-2	0-2	95-100	85-100	50-75	15-30	---	NP
	30-60	Stratified sand to sandy loam.	SM, SP-SM	A-2	0-2	90-100	80-100	50-80	10-35	---	NP
6B, 6C, 6E-------- Kalkaska	0-6	Sand--------------	SM, SP-SM	A-1, A-2, A-3	0	100	95-100	40-70	5-15	---	NP
	6-32	Sand--------------	SM, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-75	5-15	---	NP
	32-60	Sand--------------	SP, SP-SM	A-1, A-2, A-3	0	100	95-100	40-80	0-10	---	NP
7----------------- Lupton	0-7	Sapric material	PT	A-8	---	---	---	---	---	---	---
	7-60	Sapric material	PT	A-8	---	---	---	---	---	---	---
10B, 10C---------- Manistee	0-10	Loamy sand--------	SM	A-2-4	0-2	95-100	95-100	50-75	15-30	---	NP
	10-24	Sand, loamy sand, fine sand.	SP-SM, SM	A-2-4	0-2	95-100	95-100	50-75	10-25	---	NP
	24-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	90-100	80-95	50-80	25-45
11B*, 11C*, 11E*: Montcalm---------	0-7	Loamy sand--------	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	7-30	Loamy sand, sand	SM	A-2	0-2	95-100	85-100	50-75	15-30	---	NP
	30-60	Stratified sand to sandy loam.	SM, SP-SM	A-2	0-2	90-100	80-100	50-80	10-35	---	NP
Graycalm---------	0-2	Sand--------------	SM, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-70	5-15	---	NP
	2-24	Sand, loamy sand	SP-SM, SM	A-3, A-2, A-1	0	95-100	75-100	40-75	5-20	---	NP
	24-60	Sand, loamy sand, loamy coarse sand.	SM, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-75	5-20	---	NP
12B, 12C---------- Nester	0-9	Sandy loam--------	SM, SC, SM-SC	A-2, A-4	0-5	90-100	85-100	50-70	25-40	<25	NP-10
	9-38	Clay loam, silty clay loam, clay.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-100	65-90	35-60	15-30
	38-60	Clay loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	95-100	90-100	65-90	30-45	10-20
13B, 13C, 13E----- Rubicon	0-5	Sand--------------	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-70	5-15	---	NP
	5-10	Sand--------------	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-70	5-15	---	NP
	10-60	Sand--------------	SP, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-65	0-10	---	NP

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
14A--------------- Otisco	0-8	Loamy sand-------	SM, SP-SM, SC, SM-SC	A-2, A-3	0	95-100	95-100	50-75	5-30	<20	NP-10
	8-16	Loamy sand, sand	SM, SP-SM, SC, SM-SC	A-2, A-3	0	95-100	95-100	50-75	5-30	<20	NP-10
	16-55	Stratified sand to loam.	SM, SP-SM, CL, SC	A-2, A-4, A-3, A-6	0	95-100	95-100	50-90	5-65	15-40	NP-15
	55-60	Sand, loamy sand	SM, SC, SP-SM, SM-SC	A-2, A-3	0	95-100	95-100	50-75	5-30	<20	NP-10
15B*, 15C*, 15E*:											
East Lake-------	0-4	Sand-------------	SM, SP-SM	A-1, A-2-4, A-3	0	95-100	80-100	40-70	5-15	---	NP
	4-28	Sand, loamy sand, gravelly sand.	SM, SP-SM	A-1, A-2-4, A-3	0	90-100	75-100	40-75	5-15	---	NP
	28-60	Gravelly sand, very gravelly sand, sand.	GP, SP-SM, SP, GP-GM	A-1, A-3, A-2-4	0	40-90	25-80	20-60	0-10	---	NP
Rubicon---------	0-5	Sand-------------	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-70	5-15	---	NP
	5-10	Sand-------------	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-70	5-15	---	NP
	10-60	Sand-------------	SP, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-65	0-10	---	NP
16A-------------- AuGres	0-12	Loamy sand-------	SP-SM, SM	A-2-4	0	95-100	85-100	50-75	10-25	---	NP
	12-21	Sand, loamy sand	SP-SM, SP, SM	A-2-4, A-3	0	95-100	85-100	60-80	0-15	---	NP
	21-60	Sand-------------	SP, SP-SM	A-3, A-2-4	0	95-100	85-100	50-90	0-10	---	NP
17--------------- Carbondale	0-37	Sapric material	PT	A-8	0	---	---	---	---	---	---
	37-60	Hemic material---	PT	A-8	0	---	---	---	---	---	---
19B-------------- Grayling	0-19	Sand-------------	SM, SP-SM	A-1, A-2, A-3	0	100	90-100	35-65	5-15	---	NP
	19-60	Sand, coarse sand	SP, SP-SM	A-1, A-3, A-2	0	100	90-100	40-55	0-10	---	NP
20--------------- Tawas	0-22	Sapric material	PT	A-8	0	---	---	---	---	---	---
	22-60	Fine sand, sand, loamy sand.	SP, SM, SP-SM	A-3, A-2-4	0	80-100	60-100	50-75	0-20	---	NP
22--------------- Roscommon	0-4	Mucky sand-------	SM, SP, SP-SM	A-2, A-3, A-1	0	100	90-100	40-70	0-15	---	NP
	4-60	Sand, loamy sand, coarse sand.	SP, SP-SM, SM	A-1, A-2, A-3	0	95-100	85-100	40-70	0-15	---	NP
23A-------------- Kawkawlin Variant	0-8	Sandy loam-------	SM, SM-SC	A-4, A-2	0-3	95-100	95-100	60-70	30-40	12-20	2-7
	8-28	Clay loam, silty clay loam, clay.	CL, CH	A-7	0-3	95-100	90-100	85-100	60-90	45-55	20-30
	28-33	Clay loam, silty clay loam.	CL	A-7	0-3	95-100	90-100	85-100	60-90	40-50	18-25
	36-60	Sand-------------	SP, SP-SM	A-1, A-2, A-3	0-3	95-100	90-100	40-65	0-10	---	NP
30--------------- Brevort	0-9	Loamy sand-------	SP, SM, SP-SM	A-2-4, A-3	0-5	90-100	80-100	50-75	0-30	---	NP
	9-23	Sand, loamy sand, loamy fine sand.	SP, SM, SP-SM	A-2-4, A-3	0-5	90-100	80-100	50-75	0-30	<20	NP-4
	23-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	80-100	80-100	55-95	17-45	4-22

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
34A Gladwin	0-7	Loamy sand	SM, SP-SM	A-2	0-5	90-100	65-95	55-70	10-30	<20	NP-4
	7-16	Sand, loamy sand	SM, SP-SM	A-1, A-2, A-3	0-5	90-100	65-95	45-70	5-30	<20	NP-4
	16-24	Gravelly loamy sand, sandy loam, gravelly sandy loam.	SM, SM-SC, SC	A-2	0-5	85-100	65-90	55-75	15-35	12-35	NP-16
	24-60	Gravelly sand, sand.	SP, GP, SP-SM, GP-GM	A-1	0-10	40-80	35-70	20-45	0-10	---	NP
36B Dighton	0-10	Sandy loam	SM, SM-SC	A-4, A-2	0	100	95-100	60-70	30-40	12-20	2-7
	10-39	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	95-100	90-100	70-95	35-70	15-42
	39-60	Sand, fine sand, gravelly sand.	SP, SM, SP-SM	A-3, A-1, A-2	0	70-100	45-100	15-70	2-25	<20	NP
37 Sims	0-8	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	90-95	60-75	23-38	5-15
	8-26	Clay loam, silty clay loam, clay.	CL, CH	A-7	0-5	95-100	90-100	90-95	65-85	45-55	20-30
	26-60	Clay loam, silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-95	70-85	45-55	20-30
40A Iosco	0-11	Loamy sand	SM	A-2-4	0	95-100	95-100	50-70	15-30	---	NP
	11-26	Loamy sand, sand, loamy fine sand.	SM, SP-SM	A-2-4, A-3	0	95-100	95-100	50-75	5-30	<20	NP-4
	26-60	Silty clay loam, sandy loam, loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0	95-100	95-100	65-100	35-95	20-40	5-25
42B*, 42C*, 42E*: Graycalm	0-2	Sand	SM, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-70	5-15	---	NP
	2-24	Sand, loamy sand	SP-SM, SM	A-3, A-2, A-1	0	95-100	75-100	40-75	5-20	---	NP
	24-60	Sand, loamy sand, loamy coarse sand.	SM, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-75	5-20	---	NP
	60-70	Sand, coarse sand	SP, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-75	0-15	---	NP
Rubicon	0-5	Sand	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-70	5-15	---	NP
	5-10	Sand	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-70	5-15	---	NP
	10-60	Sand	SP, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-65	0-10	---	NP
46 Loxley	0-5	Hemic material	PT	A-8	0	---	---	---	---	---	---
	5-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
50A Kawkawlin	0-8	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	80-100	55-85	25-40	2-15
	8-35	Clay loam, silty clay loam, clay.	CL, CH	A-6, A-7	0-5	95-100	90-100	85-100	60-90	25-55	11-30
	35-60	Clay loam, silty clay loam.	CL	A-6	0-5	95-100	90-100	85-100	60-90	25-36	11-18
53 Cathro	0-12	Sapric material	PT	A-8	0	---	---	---	---	---	---
	12-24	Sapric material	PT	A-8	0	---	---	---	---	---	---
	24-60	Sandy loam, loam, clay loam.	SM, ML, SC, CL	A-4	0-5	80-100	65-100	60-100	35-90	<25	3-10
64*: Fluvaquents.											
Histosols.											
65*. Pits											
66*. Udipsamments											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cm^3	In/hr	In/in	pH					Pct
3A	0-7	0-10	1.25-1.55	6.0-20	0.07-0.09	3.6-7.3	Low	0.15	5	1	.5-2
Croswell	7-31	0-10	1.25-1.60	6.0-20	0.06-0.08	3.6-7.3	Low	0.15			
	31-60	0-10	1.25-1.60	6.0-20	0.05-0.07	5.1-8.4	Low	0.15			
5B*, 5C*, 5E*:											
Emmet	0-9	5-15	1.10-1.65	2.0-6.0	0.12-0.15	6.1-6.5	Low	0.20	5	3	1-3
	9-22	10-18	1.20-1.70	2.0-6.0	0.11-0.14	6.1-6.5	Low	0.20			
	22-43	15-25	1.30-2.00	0.6-2.0	0.11-0.18	6.6-7.8	Moderate	0.32			
	43-60	8-18	1.20-1.65	2.0-6.0	0.08-0.12	7.4-8.4	Low	0.32			
Montcalm	0-7	2-10	1.15-1.60	2.0-6.0	0.10-0.12	5.1-6.5	Low	0.17	5	2	.5-3
	7-30	8-15	1.20-1.60	2.0-6.0	0.06-0.10	5.1-6.5	Low	0.17			
	30-60	2-18	1.20-1.60	2.0-6.0	0.04-0.13	5.1-6.5	Low	0.17			
6B, 6C, 6E	0-6	0-10	1.25-1.45	6.0-20	0.05-0.09	4.5-6.0	Low	0.15	5	1	1-4
Kalkaska	6-32	0-10	1.35-1.45	6.0-20	0.06-0.08	4.5-6.0	Low	0.15			
	32-60	0-10	1.35-1.45	6.0-20	0.04-0.06	5.1-6.5	Low	0.15			
7	0-7	---	0.10-0.35	0.2-6.0	0.35-0.45	5.6-7.8	-------------	----	2	2	70-90
Lupton	7-60	---	0.10-0.35	0.2-6.0	0.35-0.45	5.6-7.8	-------------	----			
10B, 10C	0-10	3-12	1.15-1.60	6.0-20	0.10-0.12	5.1-7.3	Low	0.17	4	2	2-4
Manistee	10-24	2-12	1.25-1.60	6.0-20	0.06-0.10	5.1-7.3	Low	0.17			
	24-60	35-60	1.50-1.70	0.06-0.2	0.08-0.12	5.1-8.4	High	0.32			
11B*, 11C*, 11E*:											
Montcalm	0-7	2-10	1.15-1.60	2.0-6.0	0.10-0.12	5.1-6.5	Low	0.17	5	2	.5-3
	7-30	8-15	1.20-1.60	2.0-6.0	0.06-0.10	5.1-6.5	Low	0.17			
	30-60	2-18	1.20-1.60	2.0-6.0	0.04-0.13	5.1-6.5	Low	0.17			
Graycalm	0-2	0-10	1.30-1.55	6.0-20	0.04-0.10	4.5-6.5	Low	0.15	5	1	.5-2
	2-24	0-15	1.25-1.60	6.0-20	0.05-0.10	4.5-6.5	Low	0.15			
	24-60	0-10	1.50-1.65	6.0-20	0.04-0.09	4.5-6.5	Low	0.15			
12B, 12C	0-9	0-18	1.50-1.85	2.0-6.0	0.13-0.15	5.1-7.3	Low	0.24	5	3	1-3
Nester	9-38	35-45	1.55-1.80	0.2-0.6	0.10-0.20	5.1-7.3	Moderate	0.32			
	38-60	35-45	1.65-1.95	0.2-0.6	0.14-0.20	7.9-8.4	Moderate	0.32			
13B, 13C, 13E	0-5	0-5	1.36-1.41	6.0-20	0.05-0.09	4.5-6.0	Low	0.15	5	1	---
Rubicon	5-10	0-10	1.30-1.60	6.0-20	0.04-0.08	4.5-6.0	Low	0.15			
	10-60	0-5	1.40-1.55	6.0-20	0.04-0.06	4.5-6.5	Low	0.15			
14A	0-8	0-12	1.25-1.40	2.0-20	0.07-0.12	5.1-6.5	Low	0.17	5	2	2-4
Otisco	8-16	2-12	1.25-1.40	2.0-20	0.06-0.11	5.1-6.5	Low	0.17			
	16-55	5-22	1.35-1.45	2.0-20	0.05-0.17	6.1-7.8	Low	0.17			
	55-60	0-12	1.25-1.50	2.0-20	0.05-0.10	6.6-7.8	Low	0.17			
15B*, 15C*, 15E*:											
East Lake	0-4	0-8	1.30-1.60	6.0-20	0.05-0.09	5.6-7.3	Low	0.15	5	1	.5-2
	4-28	0-10	1.30-1.60	6.0-20	0.07-0.10	5.6-7.3	Low	0.15			
	28-60	0-10	1.50-1.65	>20	0.02-0.06	7.4-8.4	Low	0.15			
Rubicon	0-5	0-5	1.36-1.41	6.0-20	0.05-0.09	4.5-6.0	Low	0.15	5	1	---
	5-10	0-10	1.30-1.60	6.0-20	0.04-0.08	4.5-6.0	Low	0.15			
	10-60	0-5	1.40-1.55	6.0-20	0.04-0.06	4.5-6.5	Low	0.15			
16A	0-12	0-8	0.65-1.55	6.0-20	0.07-0.10	4.5-7.3	Low	0.15	5	2	.5-8
AuGres	12-21	1-15	1.20-1.55	6.0-20	0.06-0.09	4.5-7.3	Low	0.15			
	21-60	0-8	1.20-1.65	6.0-20	0.05-0.07	5.1-7.3	Low	0.15			
17	0-37	---	0.15-0.40	0.2-6.0	0.35-0.45	5.6-7.8	-------------	----	2	2	40-65
Carbondale	37-60	---	0.10-0.20	0.6-6.0	0.45-0.55	5.6-7.8	-------------	----			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cm³	In/hr	In/in	pH					Pct
19B	0-19	0-10	1.30-1.65	6.0-20	0.05-0.09	4.5-5.0	Low	0.15	5	1	---
Grayling	19-60	0-10	1.45-1.65	6.0-20	0.04-0.06	4.5-6.5	Low	0.15			
20	0-22	---	0.30-0.55	0.2-6.0	0.35-0.45	4.5-7.8	---	----	2	2	40-60
Tawas	22-60	0-10	1.40-1.65	6.0-20	0.03-0.10	5.6-8.4	Low	----			
22	0-4	0-10	0.90-1.60	6.0-20	0.06-0.18	5.6-7.8	Low	0.17	5	1	4-15
Roscommon	4-60	0-10	1.45-1.75	6.0-20	0.05-0.07	5.6-8.4	Low	0.17			
23A	0-8	5-20	1.45-1.70	2.0-6.0	0.12-0.15	5.1-6.5	Low	0.24	5	3	2-4
Kawkawlin	8-28	35-45	1.45-1.60	0.2-0.6	0.10-0.20	5.1-6.5	Moderate	0.24			
Variant	28-33	30-40	1.50-1.60	0.2-0.6	0.13-0.20	7.9-8.4	Moderate	0.24			
	36-60	0-5	1.40-1.55	6.0-20	0.04-0.06	6.6-7.3	Low	0.15			
30	0-9	0-15	1.35-1.50	6.0-20	0.07-0.12	5.6-7.8	Low	0.17	5	2	1-4
Brevort	9-23	2-15	1.40-1.55	2.0-20	0.06-0.11	6.1-7.8	Low	0.17			
	23-60	10-35	1.45-1.95	0.2-0.6	0.14-0.22	7.4-8.4	Moderate	0.43			
34A	0-7	0-12	1.25-1.40	6.0-20	0.08-0.12	6.1-7.8	Low	0.17	4	2	2-4
Gladwin	7-16	2-15	1.35-1.45	6.0-20	0.05-0.11	6.1-7.8	Low	0.17			
	16-24	5-18	1.35-1.45	2.0-6.0	0.05-0.13	6.1-7.8	Low	0.17			
	24-60	0-5	1.25-1.50	>20	0.02-0.04	7.9-8.4	Low	0.10			
36B	0-10	12-20	1.50-1.80	2.0-6.0	0.12-0.16	5.1-6.5	Low	0.32	4	3	1-3
Dighton	10-39	35-45	1.55-1.80	0.2-0.6	0.11-0.20	5.1-6.5	Moderate	0.32			
	39-60	0-8	1.40-1.55	>6.0	0.02-0.07	5.6-8.4	Low	0.15			
37	0-8	18-27	1.35-1.55	0.6-2.0	0.20-0.22	6.1-7.8	Low	0.32	5	5	2-5
Sims	8-26	35-45	1.40-1.70	0.06-0.2	0.12-0.18	6.1-7.8	Moderate	0.32			
	26-60	35-40	1.50-1.75	0.06-0.2	0.10-0.14	7.4-8.4	Moderate	0.32			
40A	0-11	10-15	1.25-1.41	6.0-20	0.10-0.12	5.1-6.5	Low	0.17	5	2	1-4
Ioscc	11-26	0-15	1.35-1.45	6.0-20	0.06-0.11	5.1-6.5	Low	0.17			
	26-60	18-35	1.50-1.90	0.2-0.6	0.14-0.20	6.1-7.8	Moderate	0.37			
42B*, 42C*, 42E*:											
Graycalm	0-2	0-10	1.30-1.55	6.0-20	0.04-0.10	4.5-6.5	Low	0.15	5	1	.5-2
	2-24	0-15	1.25-1.60	6.0-20	0.05-0.10	4.5-6.5	Low	0.15			
	24-60	0-10	1.50-1.65	6.0-20	0.04-0.09	4.5-6.5	Low	0.15			
	60-70	0-10	1.50-1.65	6.0-20	0.04-0.06	5.1-8.4	Low	0.15			
Rubicon	0-5	0-5	1.36-1.41	6.0-20	0.05-0.09	4.5-6.0	Low	0.15	5	1	---
	5-10	0-10	1.30-1.60	6.0-20	0.04-0.08	4.5-6.0	Low	0.15			
	10-60	0-5	1.40-1.55	6.0-20	0.04-0.06	4.5-6.5	Low	0.15			
46	0-5	---	0.30-0.40	0.6-6.0	0.45-0.55	<4.5	---	----	2	5	70-90
Loxley	5-60	---	0.10-0.35	0.2-6.0	0.35-0.45	<4.5	---	----			
50A	0-8	8-27	1.45-1.70	0.6-2.0	0.20-0.24	5.1-7.3	Low	0.32	5	6	2-4
Kawkawlin	8-35	35-45	1.45-1.60	0.2-0.6	0.10-0.20	5.1-7.8	Moderate	0.32			
	35-60	30-40	1.50-1.60	0.2-0.6	0.13-0.20	7.9-8.4	Moderate	0.32			
53	0-12	---	0.28-0.45	0.2-6.0	0.45-0.55	5.6-7.8	---	----	2	2	60-85
Cathro	12-24	---	0.15-0.30	0.2-6.0	0.35-0.45	5.6-7.8	---	----			
	24-60	10-25	1.50-1.70	0.2-2.0	0.11-0.22	6.6-8.4	Low	----			
64*:											
Fluvaquents.											
Histosols.											
65*.											
Pits											
66*.											
Udipsamments											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
3A---------------- Croswell	A	None---------	---	---	2.0-3.0	Apparent	Nov-Apr	Low------	Low------	Moderate.
5B, 5C, 5E:										
Emmet------------	B	None---------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
Montcalm---------	A	None---------	---	---	>6.0	---	---	Low------	Low------	Moderate.
6B, 6C, 6E-------- Kalkaska	A	None---------	---	---	>6.0	---	---	Low------	Low------	High.
7*---------------- Lupton	A/D	None---------	---	---	+1-1.0	Apparent	Sep-May	High-----	High-----	Low.
10B, 10C---------- Manistee	A	None---------	---	---	>6.0	---	---	Low------	High-----	Moderate.
11B, 11C, 11E:										
Montcalm---------	A	None---------	---	---	>6.0	---	---	Low------	Low------	Moderate.
Graycalm---------	A	None---------	---	---	>6.0	---	---	Low------	Low------	Moderate.
12B, 12C---------- Nester	C	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
13B, 13C, 13E----- Rubicon	A	None---------	---	---	>6.0	---	---	Low------	Low------	High.
14A--------------- Otisco	A	None---------	---	---	0.5-1.5	Apparent	Nov-May	Moderate	Low------	Moderate.
15B, 15C, 15E:										
East Lake--------	A	None---------	---	---	>6.0	---	---	Low------	Low------	Moderate.
Rubicon----------	A	None---------	---	---	>6.0	---	---	Low------	Low------	High.
16A--------------- AuGres	B	None---------	---	---	0.5-1.5	Apparent	Nov-May	Moderate	Low------	Moderate.
17*--------------- Carbondale	A/D	None---------	---	---	+1-1.0	Apparent	Sep-May	High-----	High-----	Moderate.
19B--------------- Grayling	A	None---------	---	---	>6.0	---	---	Low------	Low------	Moderate
20*--------------- Tawas	A/D	None---------	---	---	+1-1.0	Apparent	Nov-May	High-----	High-----	Moderate
22*--------------- Roscommon	A/D	None---------	---	---	+1-1.0	Apparent	Sep-Jun	Moderate	High-----	Low.
23A--------------- Kawkawlin Variant	C	None---------	---	---	1.0-2.0	Apparent	Oct-May	High-----	High-----	Low.
30*--------------- Brevort	B/D	None---------	---	---	+1-1.0	Apparent	Nov-May	High-----	Low------	Moderate
34A--------------- Gladwin	A	None---------	---	---	0.5-1.5	Apparent	Nov-May	Moderate	Low------	Low.
36B--------------- Dighton	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Moderate

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
37* Sims	D	None	---	---	+1-1.0	Apparent	Nov-May	High	High	Low.
40A Iosco	B	None	---	---	0.5-1.5	Apparent	Nov-Jun	Moderate	Low	Moderate.
42B, 42C, 42E:										
Graycalm	A	None	---	---	>6.0	---	---	Low	Low	Moderate.
Rubicon	A	None	---	---	>6.0	---	---	Low	Low	High.
46* Loxley	A/D	None	---	---	+1-1.0	Apparent	Nov-May	High	High	High.
50A Kawkawlin	C	None	---	---	1.0-2.0	Apparent	Oct-May	High	High	Low.
53* Cathro	A/D	None	---	---	+1-1.0	Apparent	Nov-Jun	High	High	Low.
64:										
Fluvaquents.										
Histosols.										
65. Pits										
66. Udipsamments										

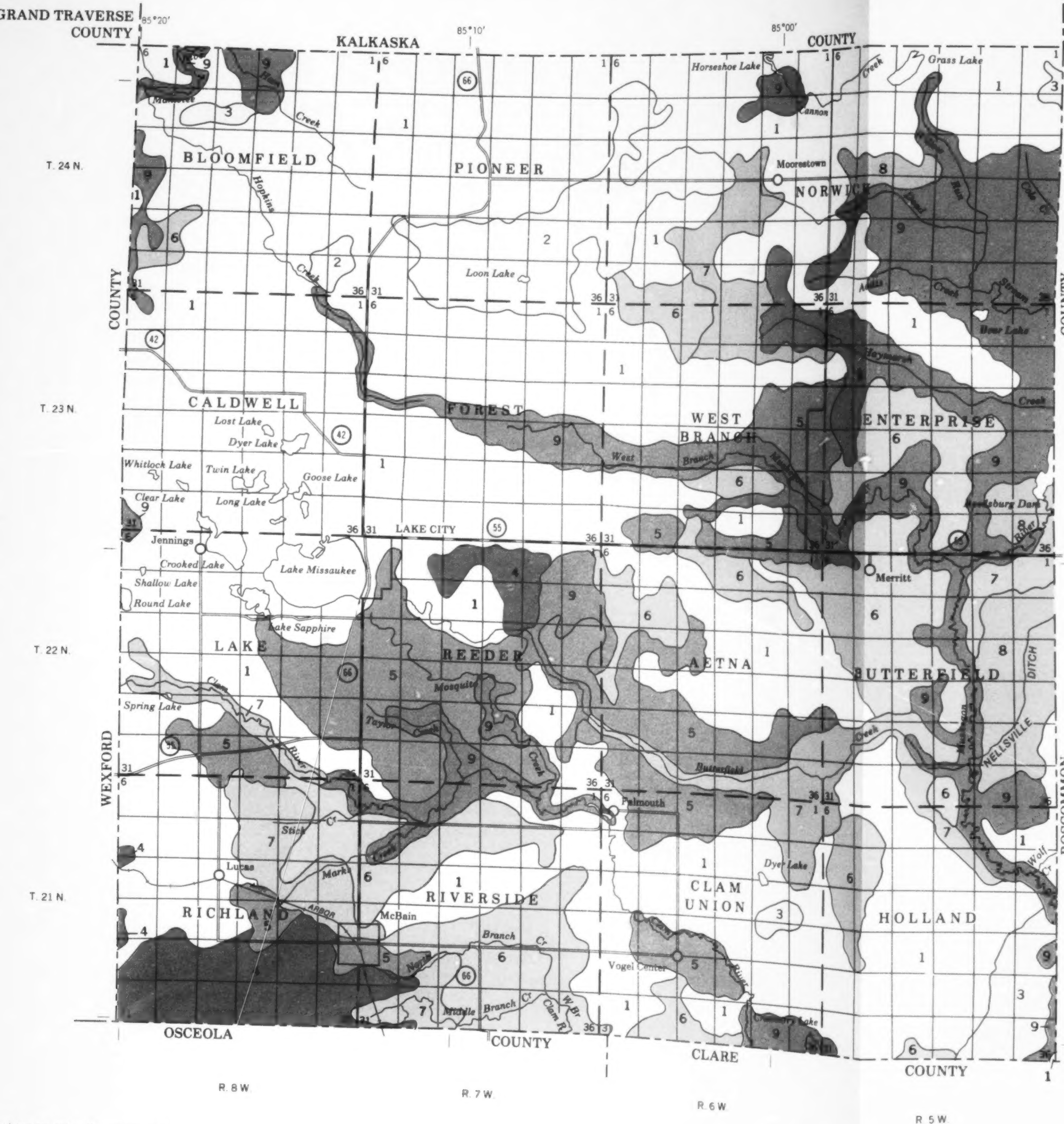
* In the "High water table--Depth" column, a plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
*AuGres	Sandy, mixed, frigid Entic Haplaquods
Brevort	Sandy over loamy, mixed, nonacid, frigid Mollic Haplaquents
Carbondale	Euic Hemic Borosaprists
Cathro	Loamy, mixed, euic Terric Borosaprists
Croswell	Sandy, mixed, frigid Entic Haplorthods
*Dighton	Clayey over sandy or sandy-skeletal, mixed Typic Eutroboralfs
East Lake	Sandy, mixed, frigid Entic Haplorthods
Emmet	Coarse-loamy, mixed Typic Eutroboralfs
Fluvaquents	Mixed, nonacid, frigid Fluvaquents
Gladwin	Sandy, mixed, frigid Alfic Haplaquods
Graycalm	Mixed, frigid Alfic Udipsamments
Grayling	Mixed, frigid Typic Udipsamments
Histosols	Euic, frigid Histosols
Iosco	Sandy over loamy, mixed, frigid Alfic Haplaquods
Kalkaska	Sandy, mixed, frigid Typic Haplorthods
Kawkawlin	Fine, mixed Aquic Eutroboralfs
Kawkawlin Variant	Clayey over sandy or sandy-skeletal, mixed Glossaquic Eutroboralfs
Loxley	Dysic Typic Borosaprists
Lupton	Euic Typic Borosaprists
Manistee	Sandy over clayey, mixed, frigid Alfic Haplorthods
Montcalm	Coarse-loamy, mixed, frigid Eutric Glossoboralfs
Nester	Fine, mixed Typic Eutroboralfs
Otisco	Sandy, mixed, frigid Alfic Haplaquods
Roscommon	Mixed, frigid Mollic Psammaquents
Rubicon	Sandy, mixed, frigid Entic Haplorthods
Sims	Fine, mixed, nonacid, frigid Mollic Haplaquepts
Tawas	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
Udipsamments	Mixed, frigid Udipsamments

* The soil is a taxadjunct to the series. See text for description of those characteristics of the soil that are outside the range of the series.

U.S. GOVERMENT PRINTING OFFICE : 1985 O - 454-890


GRAND TRAVERSE COUNTY
KALKASKA COUNTY
WEXFORD COUNTY
ROSCOMMON COUNTY
OSCEOLA COUNTY
CLARE COUNTY
85°20′
85°10′
85°00′
T. 24 N.
T. 23 N.
T. 22 N.
T. 21 N.
R. 8 W.
R. 7 W.
R. 6 W.
R. 5 W.
BLOOMFIELD
PIONEER
NORWICH
CALDWELL
FOREST
WEST BRANCH
ENTERPRISE
LAKE
REEDER
AETNA
BUTTERFIELD
RICHLAND
RIVERSIDE
CLAM UNION
HOLLAND
Moorestown
Horseshoe Lake
Grass Lake
Loon Lake
Bear Lake
Lost Lake
Dyer Lake
Whitlock Lake
Twin Lake
Goose Lake
Clear Lake
Long Lake
Jennings
LAKE CITY
Crooked Lake
Shallow Lake
Round Lake
Lake Missaukee
Lake Sapphire
Spring Lake
Merritt
Reedsburg Dam
Falmouth
Lucas
McBain
Vogel Center
Dyer Lake
Cranberry Lake
NELLSVILLE
DITCH
Manistee
Hopkins Creek
Cannon Creek
Dead Stream
Cole Cr
Addis Creek
Haymarsh Creek
West Branch
Muskegon River
Mosquito Creek
Taylor Creek
Clam River
Butterfield Creek
Stick Cr
Marks Creek
Muskegon River
Wolf Cr
North Branch Cr
Middle Branch Cr
Clam R
W. Br
ARBOR
42
55
66
1
2
3
4
5
6
7
8
9
36
31

ach area outlined on this map consists of ore than one kind of soil. The map is thus eant for general planning rather than a basis r decisions on the use of specific tracts.

RAWFORD
OUNTY

44°30'

LEGEND*

NEARLY LEVEL TO STEEP SOILS THAT ARE WELL DRAINED, SOMEWHAT EXCESSIVELY DRAINED, AND EXCESSIVELY DRAINED

1 Rubicon-Montcalm-Graycalm association: Nearly level to steep, well drained and somewhat excessively drained sandy soils on outwash plains, till plains, and moraines

2 Kalkaska association: Nearly level to steep, somewhat excessively drained sandy soils on outwash plains and moraines

3 Grayling association: Nearly level to undulating, excessively drained sandy soils on outwash plains

NEARLY LEVEL TO STEEP SOILS THAT ARE WELL DRAINED, SOMEWHAT POORLY DRAINED, AND POORLY DRAINED

4 Emmet-Montcalm association: Nearly level to steep, well drained loamy and sandy soils on moraines and till plains

5 Nester-Kawkawlin-Manistee association: Nearly level to gently rolling, well drained and somewhat poorly drained loamy and sandy soils on till plains and moraines

6 Kawkawlin-Iosco-Sims association: Nearly level, somewhat poorly drained and poorly drained loamy and sandy soils on till plains

44°20'

NEARLY LEVEL SOILS THAT ARE SOMEWHAT POORLY DRAINED, POORLY DRAINED, AND VERY POORLY DRAINED

7 AuGres-Iosco-Lupton association: Nearly level, somewhat poorly drained and very poorly drained sandy and mucky soils on outwash plains and till plains

8 Otisco-Roscommon association: Nearly level, somewhat poorly drained, poorly drained, and very poorly drained sandy soils on till plains and outwash plains

9 Lupton-Roscommon-Tawas association: Nearly level, poorly drained and very poorly drained mucky and sandy soils in upland depressions on outwash plains, till plains, and moraines

*The texture given in the descriptive headings refers to the texture of the surface layer of the major soils in each association.

N

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Compiled 1983

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MICHIGAN DEPARTMENT OF AGRICULTURE
MICHIGAN AGRICULTURAL EXPERIMENT STATION
MICHIGAN TECHNOLOGICAL UNIVERSITY

44°10'

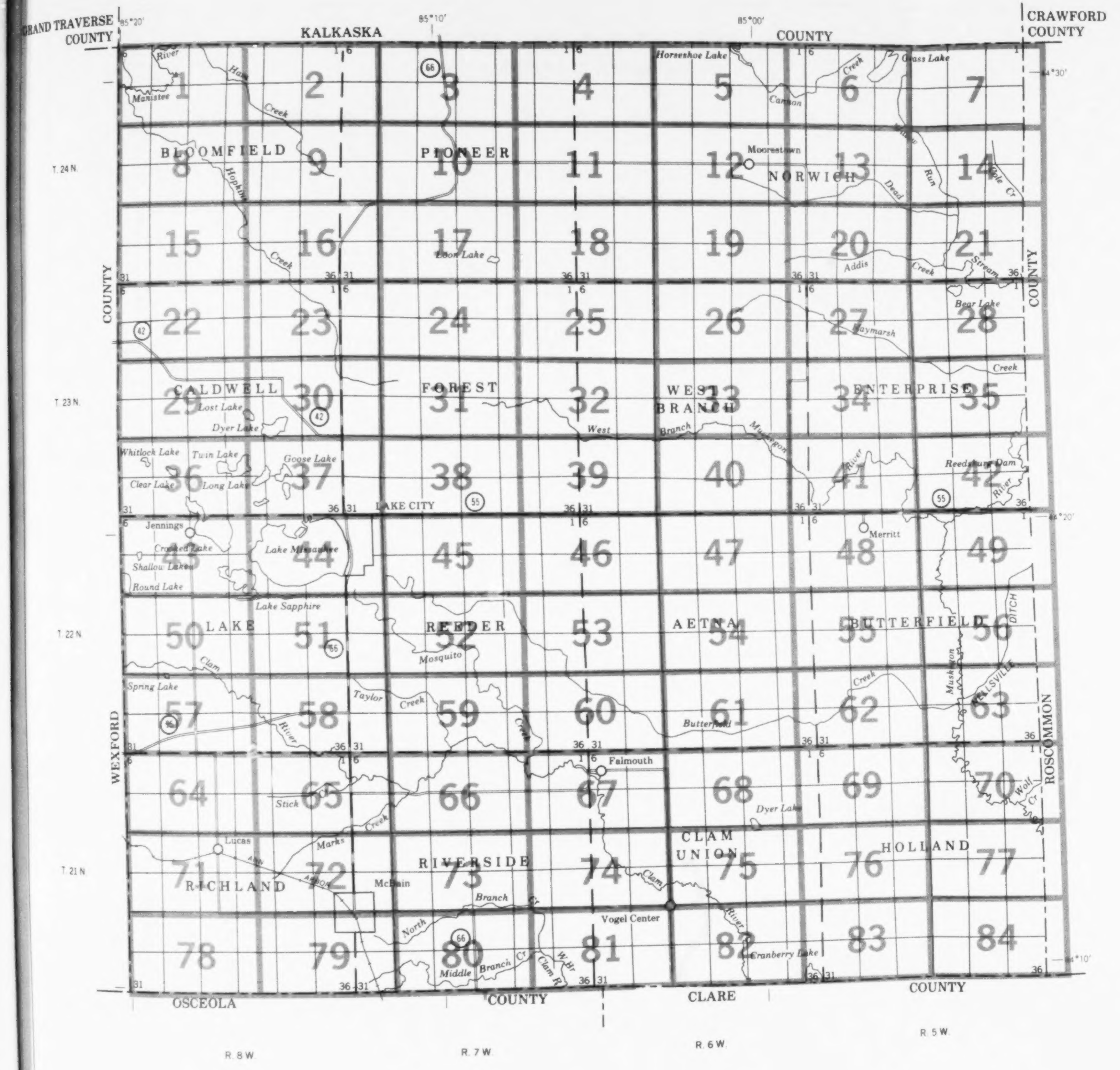
GENERAL SOIL MAP

MISSAUKEE COUNTY, MICHIGAN

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 4 8 Km


GRAND TRAVERSE COUNTY
KALKASKA COUNTY
CRAWFORD COUNTY
WEXFORD COUNTY
ROSCOMMON COUNTY
OSCEOLA COUNTY
CLARE COUNTY
85°20'
85°10'
85°00'
44°30'
44°20'
44°10'
T. 24 N.
T. 23 N.
T. 22 N.
T. 21 N.
R. 8 W.
R. 7 W.
R. 6 W.
R. 5 W.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
BLOOMFIELD
PIONEER
NORWICH
CALDWELL
FOREST
WEST BRANCH
ENTERPRISE
LAKE
REEDER
AETNA
BUTTERFIELD
RICHLAND
RIVERSIDE
CLAM UNION
HOLLAND
Manistee River
Hay Creek
Hopkins Creek
Horseshoe Lake
Cannon Creek
Grass Lake
Dead Stream
Muskrat Run
Mooreestown
Loon Lake
Addis Creek
Stream
Bear Lake
Haymarsh Creek
Lost Lake
Dyer Lake
West Branch
Muskegon River
Whitlock Lake
Twin Lake
Goose Lake
Clear Lake
Long Lake
Reedsburg Dam
River
LAKE CITY
Jennings
Crooked Lake
Shallow Lake
Round Lake
Lake Missaukee
Merritt
Lake Sapphire
Mosquito
DITCH
Clam
Spring Lake
Taylor Creek
Creek
River
Butterfield
Muskegon
WELLSVILLE
Stick
Falmouth
Dyer Lake
Wolf Cr.
Lucas
Marks
ANN ARBOR
McBain
Clam
Branch
Vogel Center
North
Middle Branch Cr.
W. Br. Clam R.
River
Cranberry Lake
66
42
55
61
36
31
1
6

N

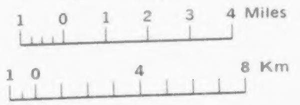
SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

MISSAUKEE COUNTY, MICHIGAN

Scale 1:253,440


1 0 1 2 3 4 Miles
1 0 4 8 Km

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

MISSAUKEE COUNTY, MICHIGAN

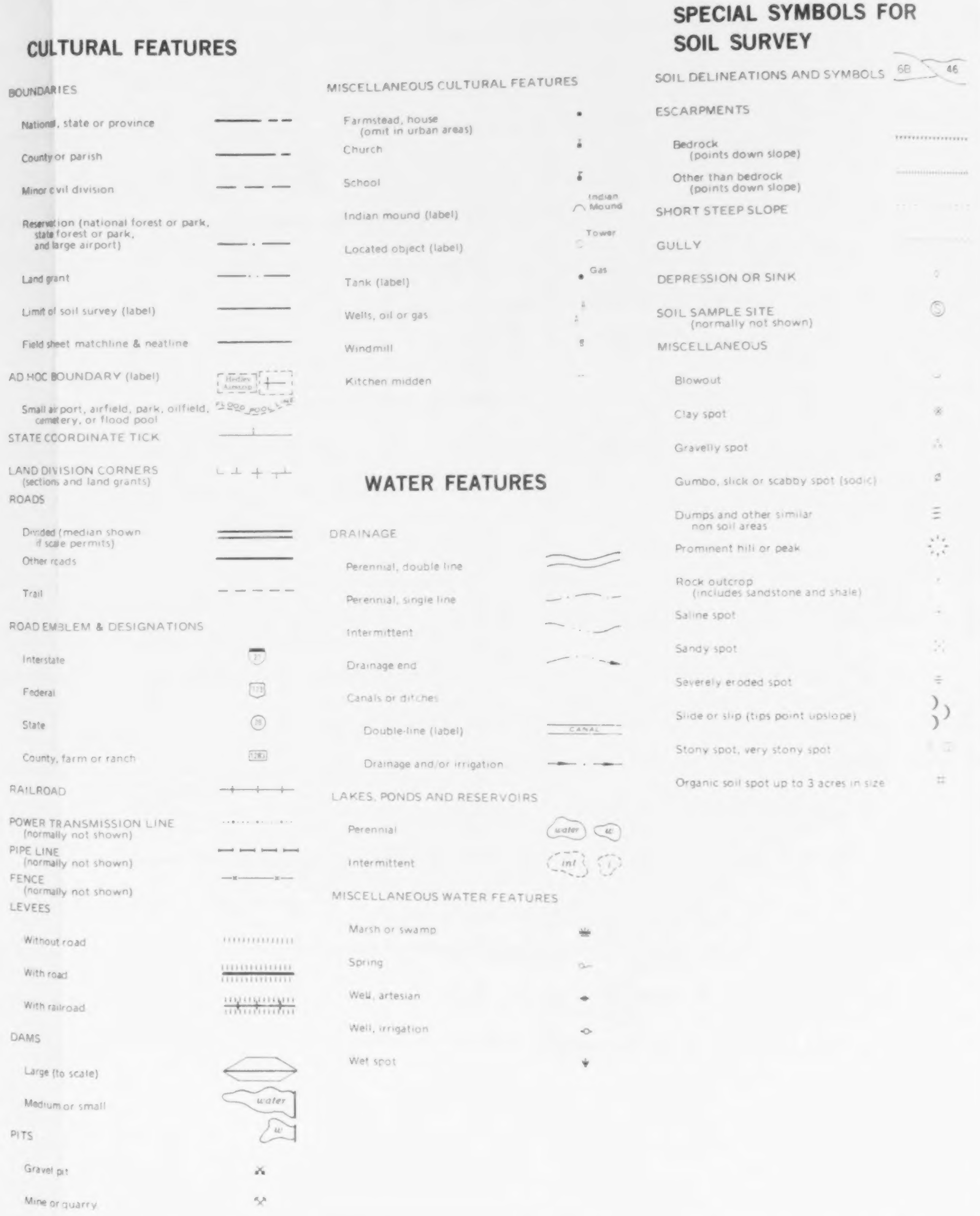
MICHIGAN DEPARTMENT OF AGRICULTURE
MICHIGAN AGRICULTURAL EXPERIMENT STATION
MICHIGAN TECHNOLOGICAL UNIVERSITY

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
3A	Croswell sand, 0 to 3 percent slopes
5B	Emmet-Montcalm complex, 0 to 6 percent slopes
5C	Emmet-Montcalm complex, 6 to 12 percent slopes
5E	Emmet-Montcalm complex, 12 to 30 percent slopes
6B	Kalkaska sand, 0 to 6 percent slopes
6C	Kalkaska sand, 6 to 12 percent slopes
6E	Kalkaska sand, 12 to 30 percent slopes
7	Lupton muck
10B	Manistee loamy sand, 0 to 6 percent slopes
10C	Manistee loamy sand, 6 to 12 percent slopes
11B	Montcalm-Graycalm complex, 0 to 6 percent slopes
11C	Montcalm-Graycalm complex, 6 to 12 percent slopes
11E	Montcalm-Graycalm complex, 12 to 30 percent slopes
12B	Nester sandy loam, 1 to 6 percent slopes
12C	Nester sandy loam, 6 to 12 percent slopes
13B	Rubicon sand, 0 to 6 percent slopes
13C	Rubicon sand, 6 to 12 percent slopes
13E	Rubicon sand, 12 to 30 percent slopes
14A	Otisco loamy sand, 0 to 3 percent slopes
15B	East Lake-Rubicon sands, 0 to 6 percent slopes
15C	East Lake-Rubicon sands, 6 to 12 percent slopes
15E	East Lake-Rubicon sands, 12 to 30 percent slopes
16A	AuGres loamy sand, 0 to 3 percent slopes
17	Carbondale muck
19B	Grayling sand, 0 to 6 percent slopes
20	Tawas mucky peat
22	Roscommon mucky sand
23A	Kawkawlin Variant sandy loam, 0 to 3 percent slopes
30	Brevort loamy sand
34A	Gladwin loamy sand, 0 to 3 percent slopes
36B	Dighton sandy loam, 1 to 6 percent slopes
37	Sims loam
40A	Iosco loamy sand, 0 to 3 percent slopes
42B	Graycalm-Rubicon sands, 0 to 6 percent slopes
42C	Graycalm-Rubicon sands, 6 to 12 percent slopes
42E	Graycalm-Rubicon sands 12 to 30 percent slopes
46	Loxley mucky peat
50A	Kawkawlin loam, 0 to 3 percent slopes
53	Cathro muck
64	Fluvaquents and Histosols, frequently flooded
65	Pits, sand and gravel
66	Udipsamments, nearly level

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND



CULTURAL FEATURES

BOUNDARIES
- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)
- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS
- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS
- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES
- Without road
- With road
- With railroad

DAMS
- Large (to scale)
- Medium or small

PITS
- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES
- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label)
- Located object (label)
- Tank (label)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE
- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS
- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES
- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS
- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

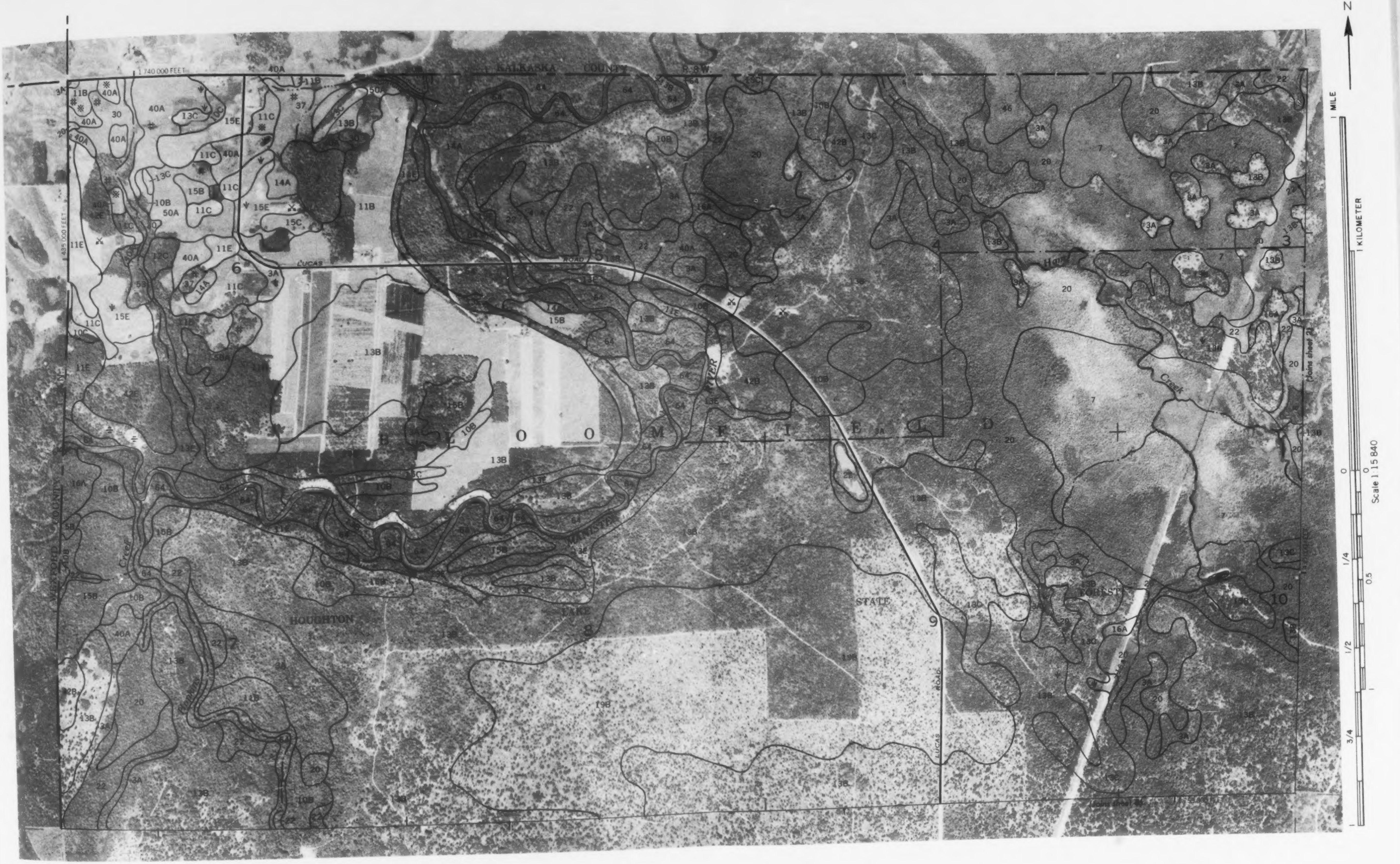
GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

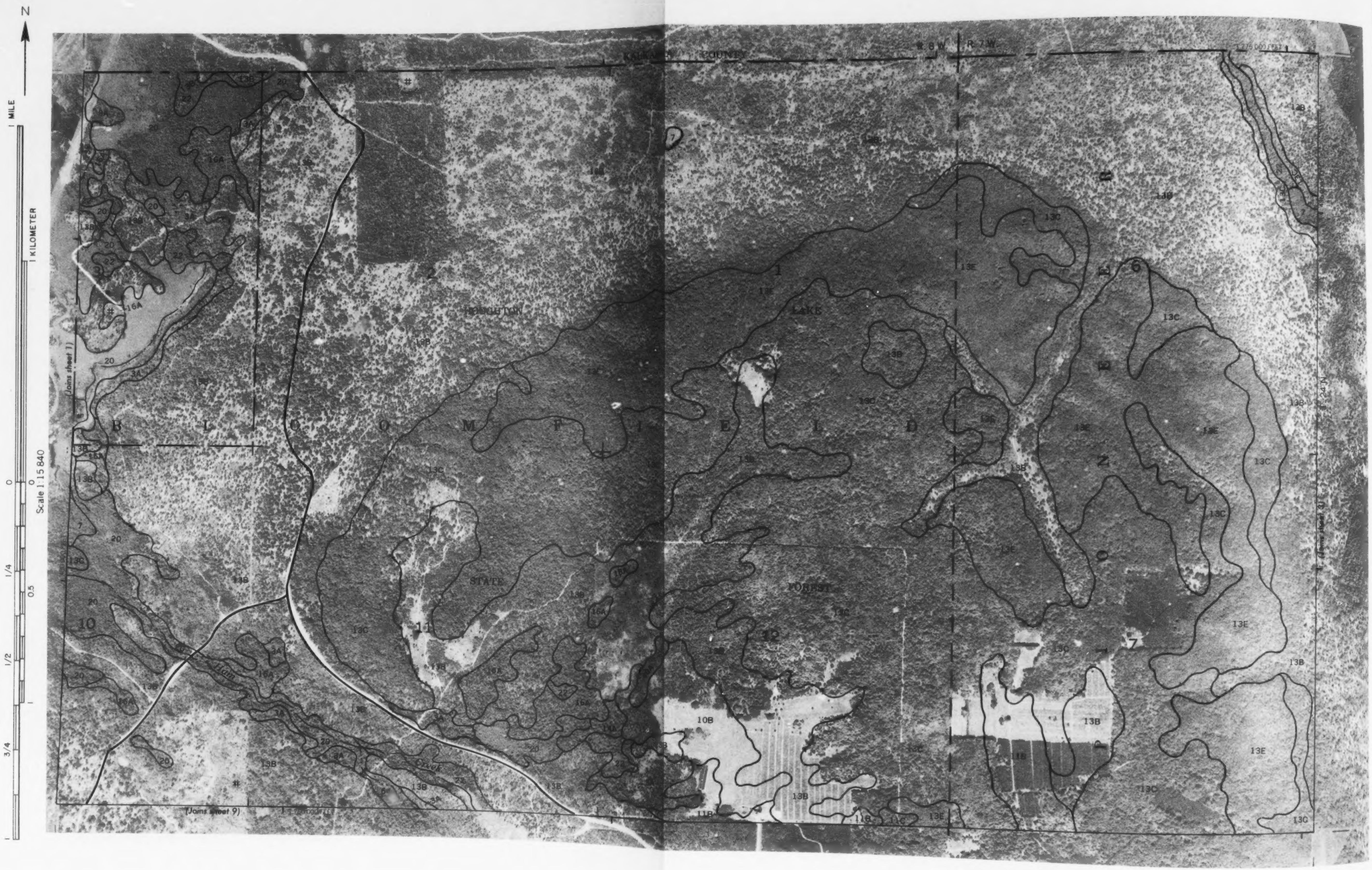
MISCELLANEOUS
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Organic soil spot up to 3 acres in size

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 1

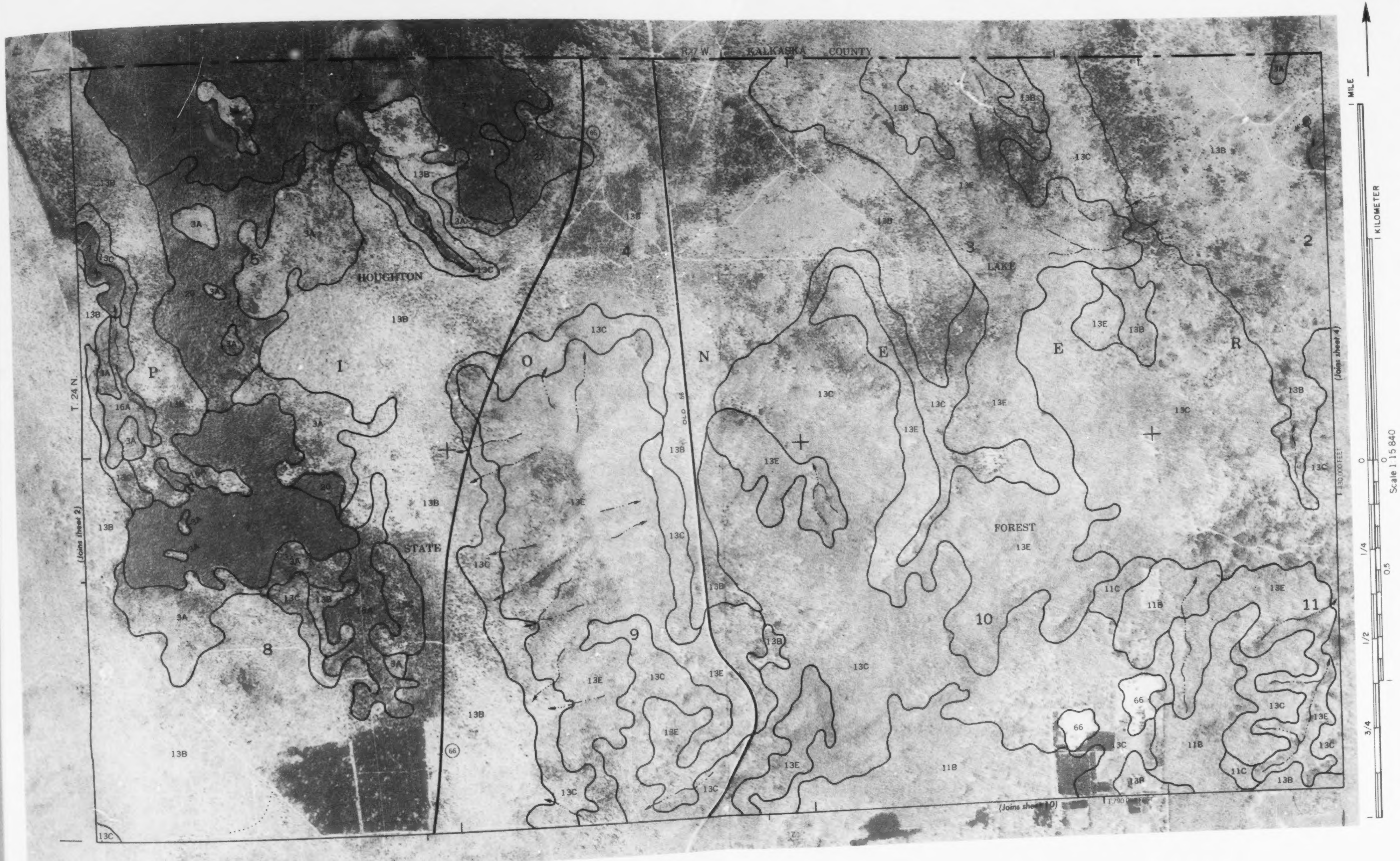

N
KALKASKA COUNTY
WEXFORD COUNTY
1 740 000 FEET
435 000 FEET
B L O O M F I E L D
HOUGHTON LAKE STATE FOREST
MANISTEE RIVER
Hay Creek
Creek
LUCAS ROAD
(Joins sheet 2)
(Joins sheet 4)
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0.5
3
4
5
6
7
8
9
10
3A
7
11B
11C
11E
13B
13C
14A
15B
15C
15E
16A
19B
20
22
30
37
40A
42B
46
50A
64

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 2

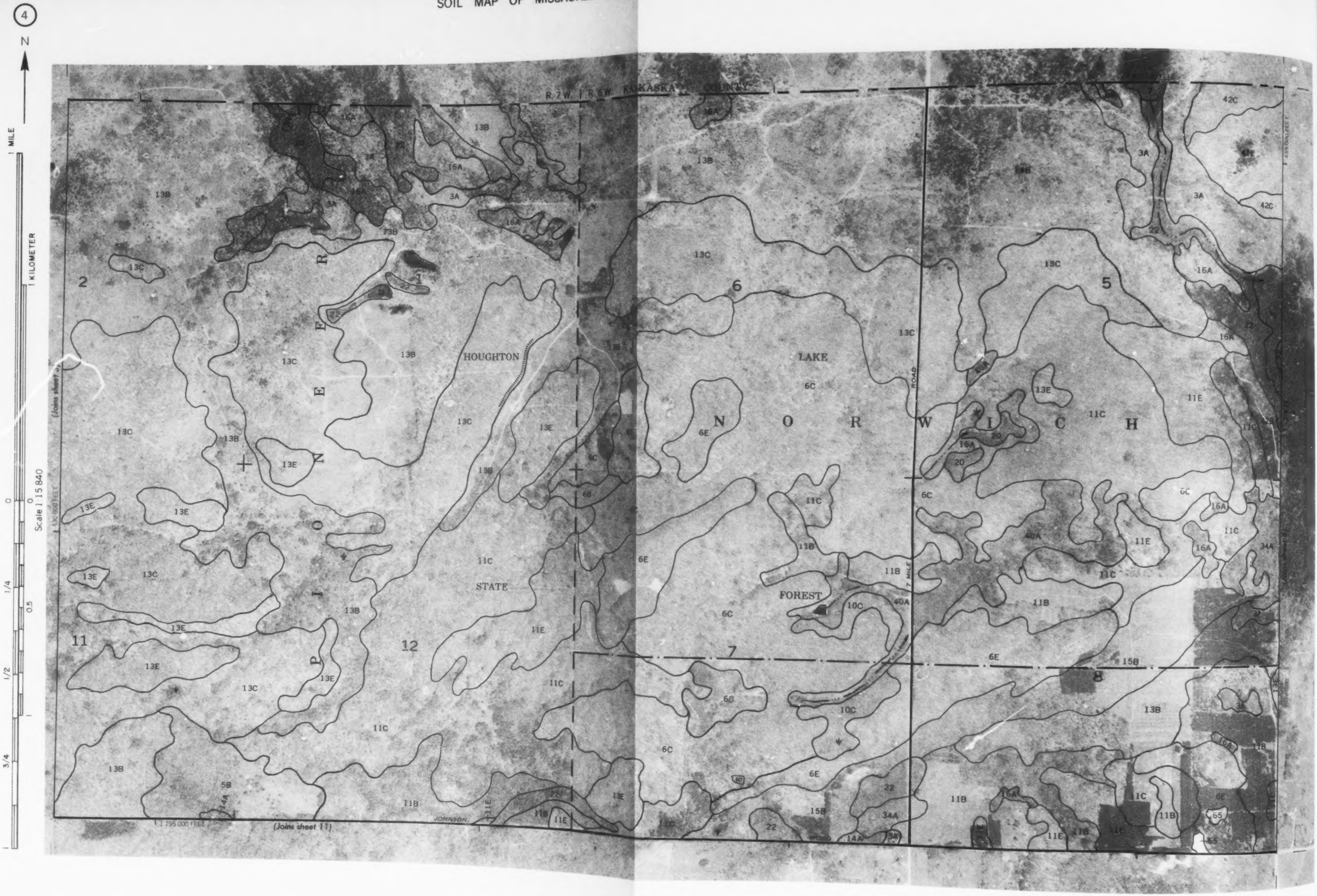
②


N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
1
Scale 1:15 840
KALKASKA COUNTY
R 8 W.
R 7 W.
BLOOMFIELD
HOUGHTON LAKE
STATE FOREST
Ham Creek
(Joins sheet 1)
(Joins sheet 9)
(Joins sheet 3)
1
2
3
6
7
10
11
12
13B
13C
13E
16A
20
22
3A
10B
11B
11C

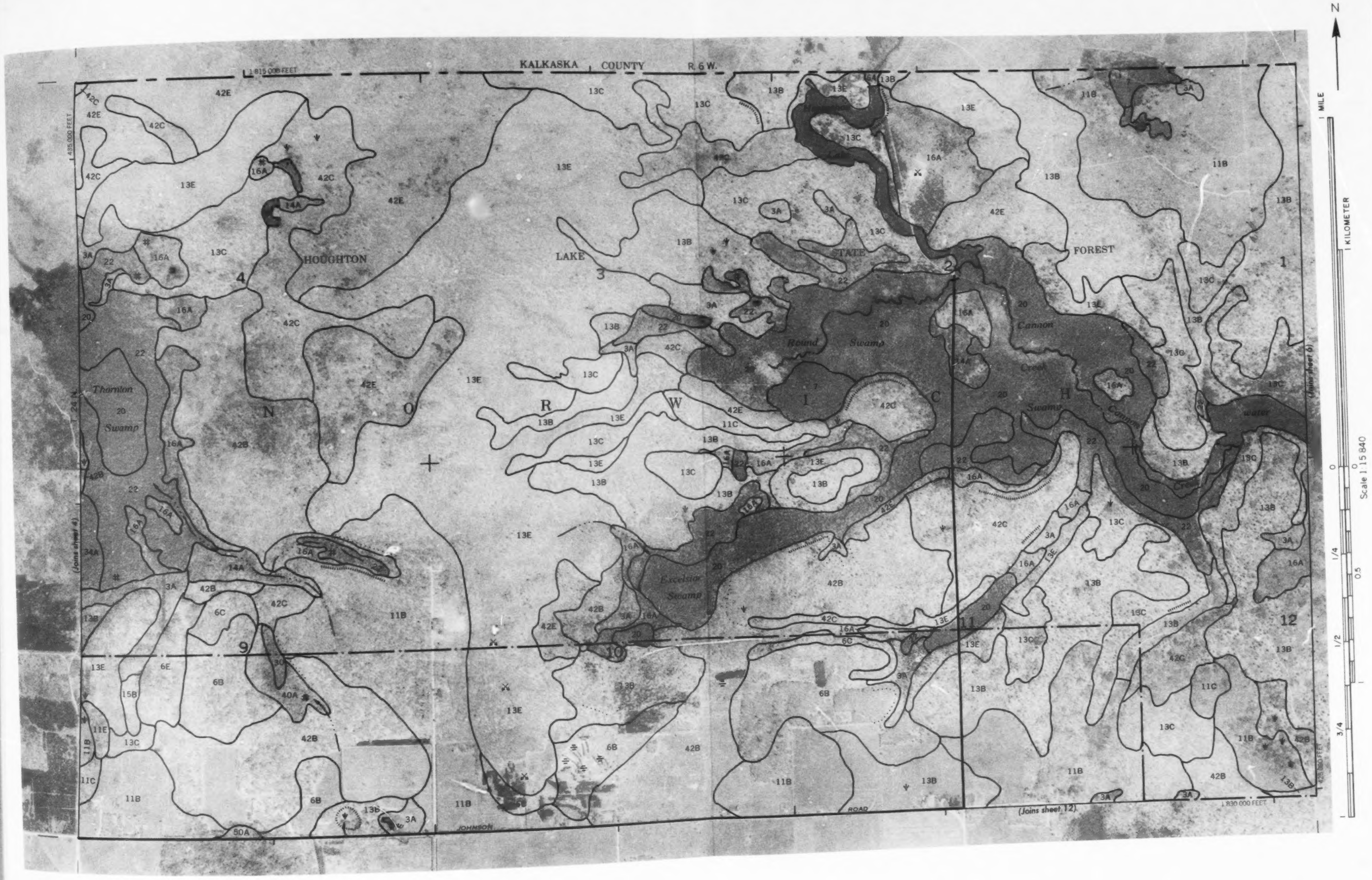
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 3


N
R.7 W.
KALKASKA COUNTY
T. 24 N.
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 10)
HOUGHTON
LAKE
STATE
FOREST
P I O N E E R
2
3
4
5
8
9
10
11
3A
13B
13C
13E
11B
11C
16A
66
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0
0.5
1
Scale 1:15 840

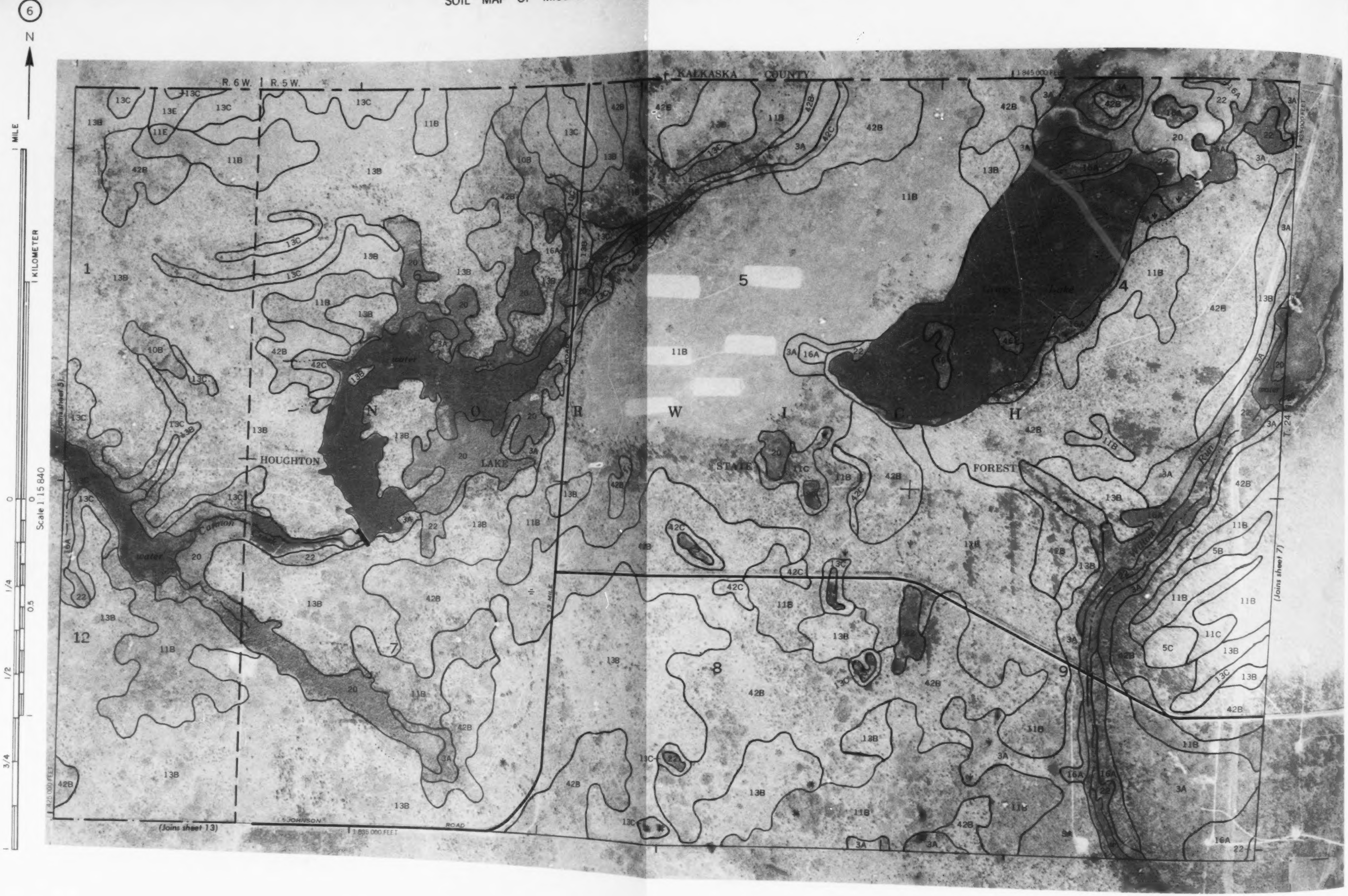
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 4

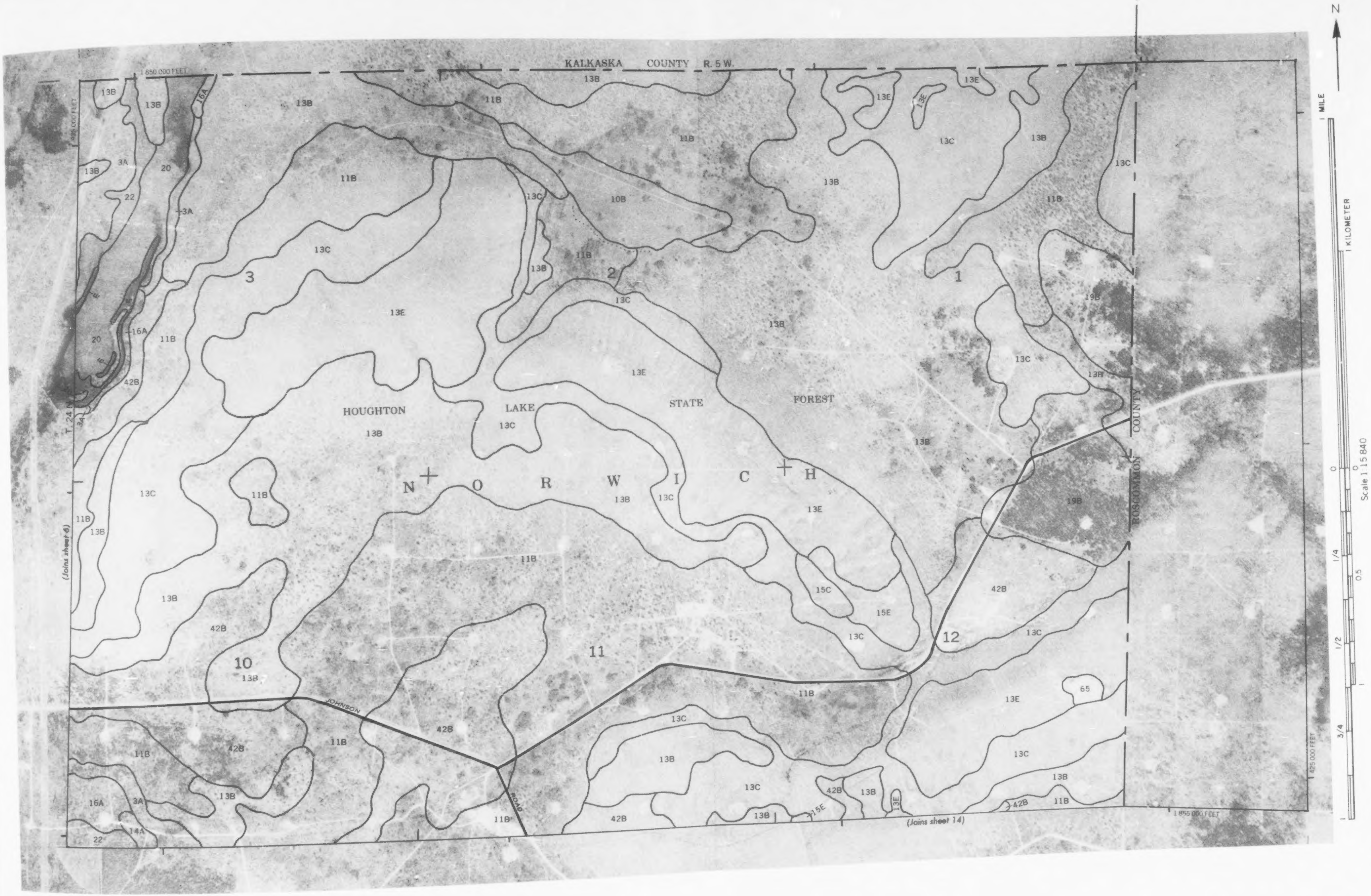

4
N
MILE
KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
R.7W.
R.6W.
KALKASKA COUNTY
PIONEER
NORWICH
HOUGHTON
LAKE
STATE
FOREST
ROAD
7 MILE
JOHNSON
(Joins sheet 3)
(Joins sheet 11)
1 795 000 FEET
430 000 FEET
2
1
6
5
11
12
7
8
3A
6B
6C
6E
10C
11B
11C
11E
13B
13C
13E
14A
15B
16A
20
22
32
34A
40A
42C
5B
65

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 5


KALKASKA COUNTY
R. 6 W.
1 815 000 FEET
435 000 FEET
T. 24 N.
HOUGHTON LAKE STATE FOREST
N O R W I C H
Thornton Swamp
Round Swamp
Cannon Creek Swamp
Cannon Creek
Excelsior Swamp
water
JOHNSON
ROAD
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 12)
1 830 000 FEET
1
2
3
4
9
10
11
12
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0
0.5
1

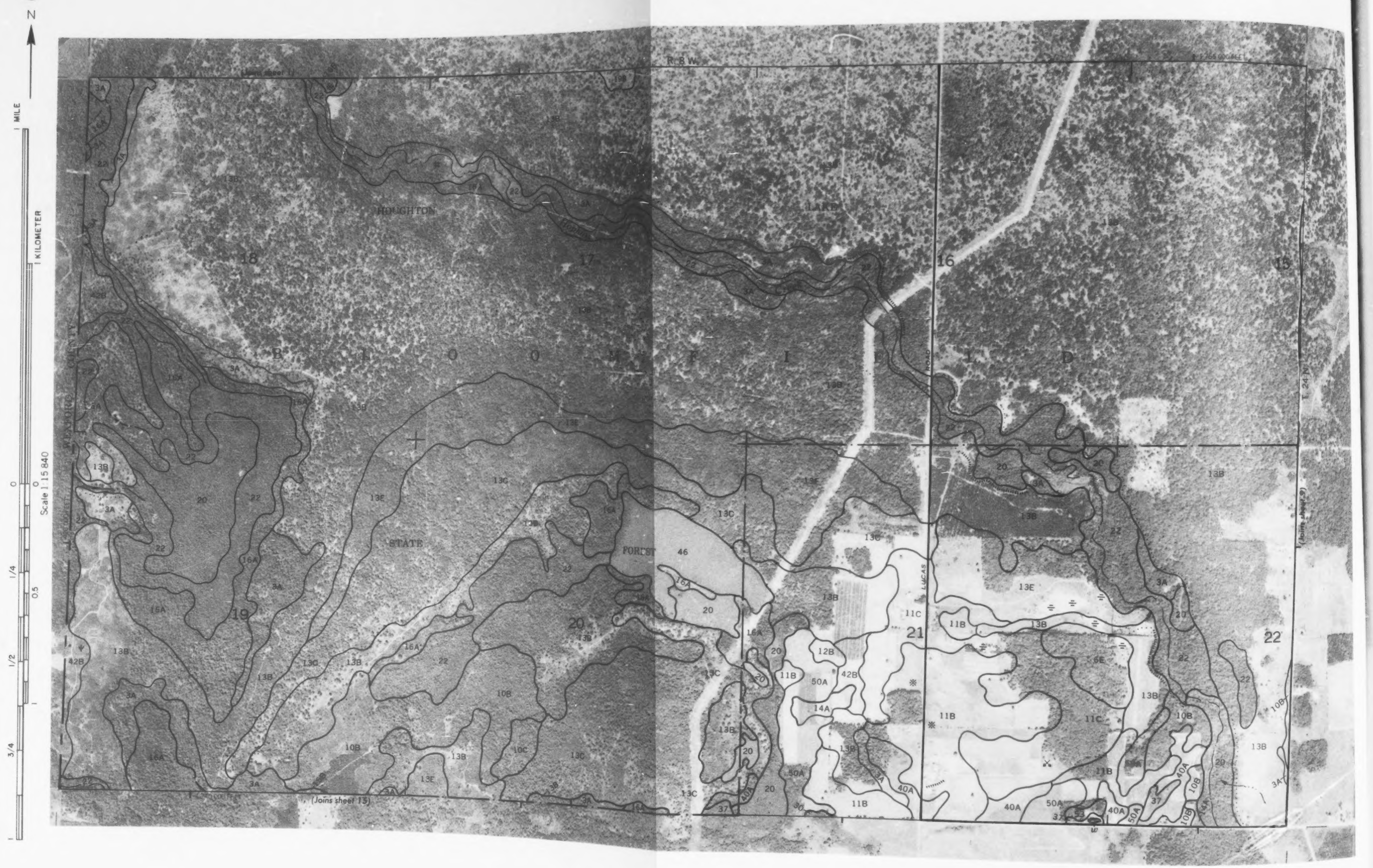
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 6


⑥
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0.5
R. 6 W.
R. 5 W.
KALKASKA COUNTY
1 845 000 FEET
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 13)
425 000 FEET
1 805 000 FEET
JOHNSON ROAD
ROAD
T. 24 N.
HOUGHTON LAKE
NORWICH STATE FOREST
water
Lake
Run
1
4
5
7
8
9
12
13C
13B
13E
11E
11B
11C
10B
42B
42C
3A
5B
5C
16A
20
22

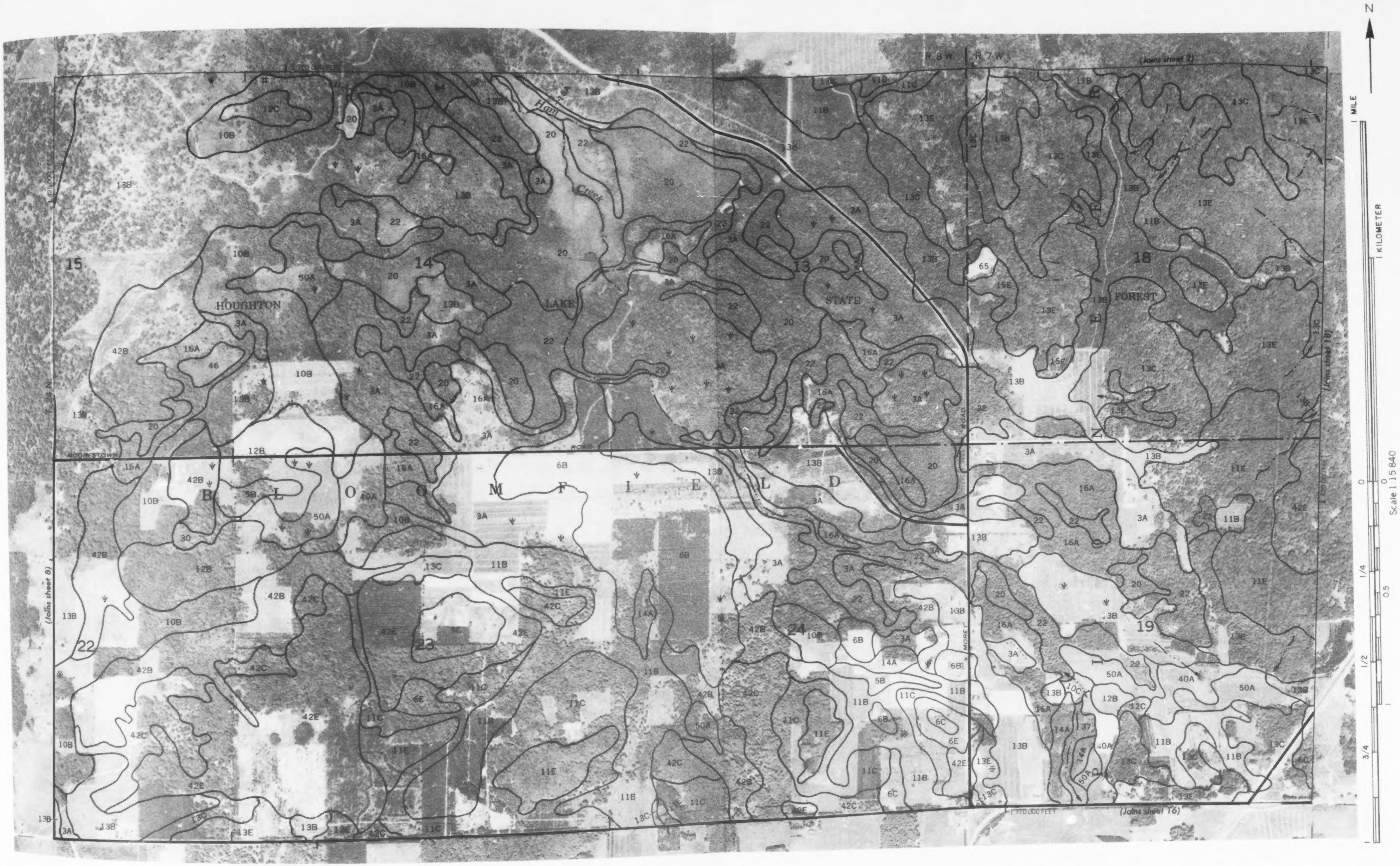

KALKASKA COUNTY R. 5 W.
1 850 000 FEET
ROSCOMMON COUNTY
T. 24 N.
(Joins sheet 6)
(Joins sheet 14)
HOUGHTON LAKE STATE FOREST
N O R W I C H
JOHNSON ROAD
1
2
3
10
11
12
13B
13C
13E
11B
10B
15C
15E
16A
19B
20
22
3A
14A
42B
65
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0.5
1 855 000 FEET

⑧

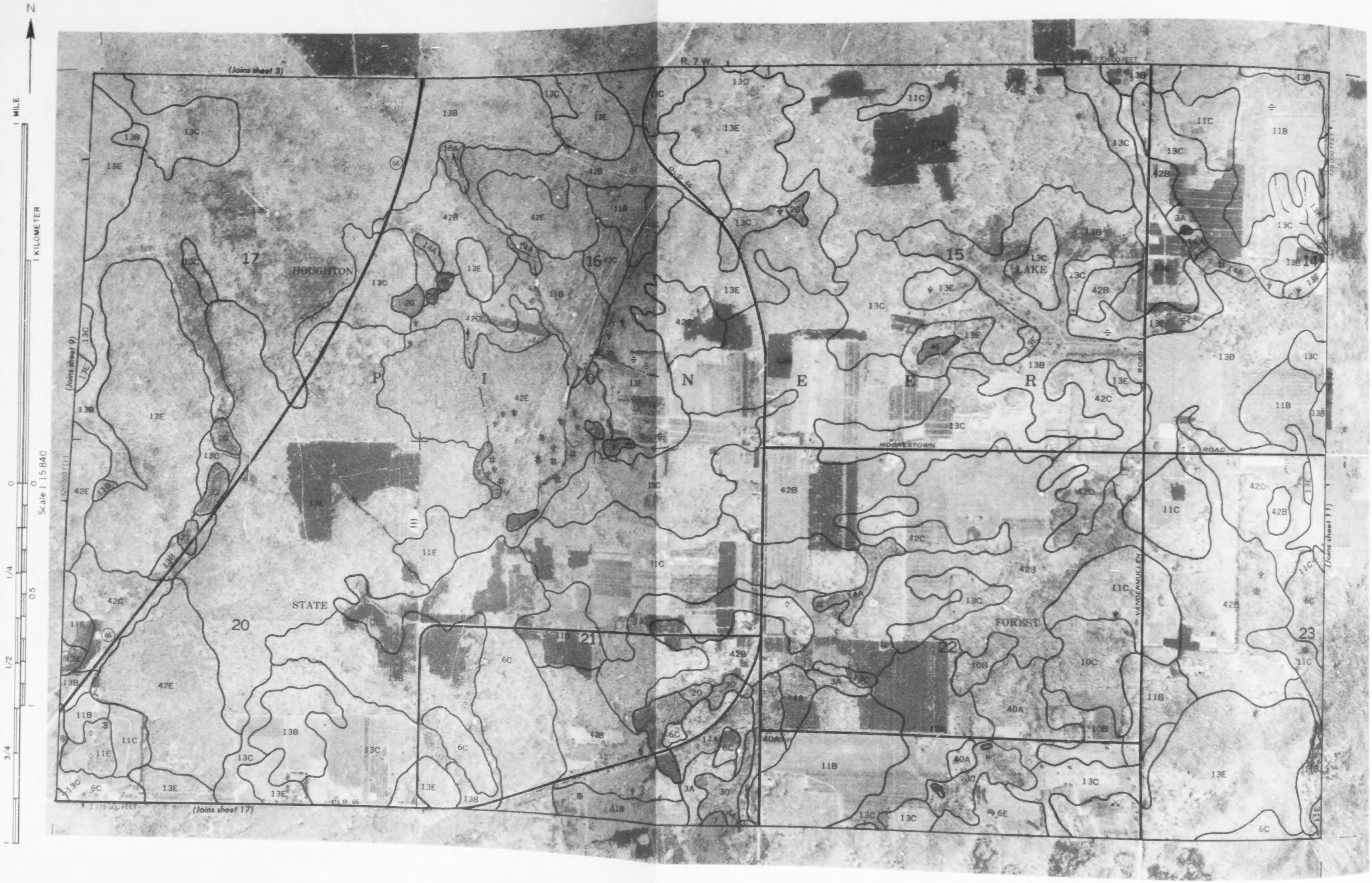
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 8


N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
R. 8 W.
T. 24 N.
(Joins sheet 1)
(Joins sheet 9)
(Joins sheet 13)
WEXFORD COUNTY
HOUGHTON
LAKE
B L O O M F I E L D
STATE
FOREST
LUCAS
ROAD
15
16
17
18
19
20
21
22
3A
10A
10B
10C
11B
11C
12B
13B
13C
13E
14A
15A
16A
20
22
37
40A
42B
46
50A
6E

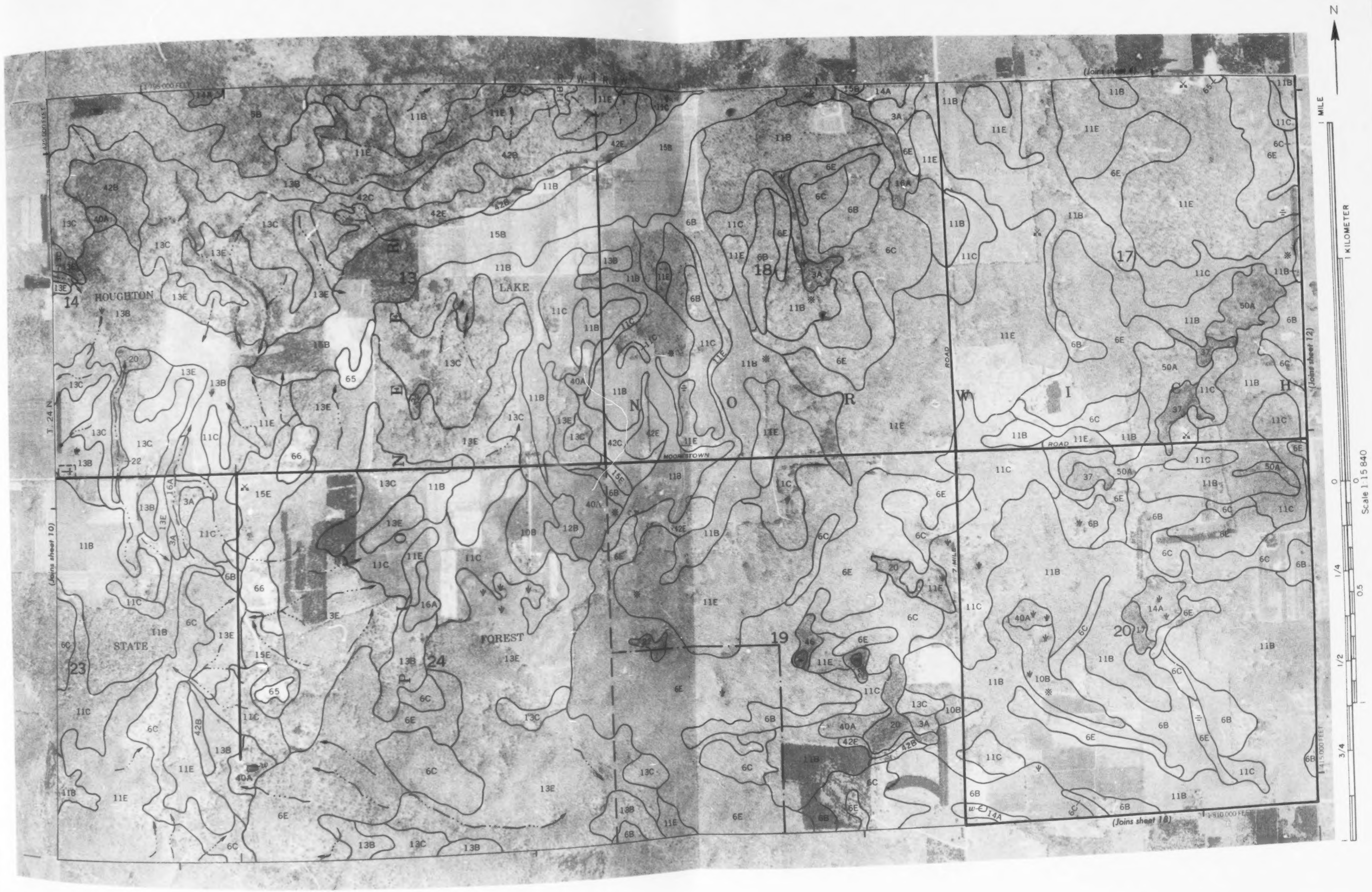
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 9


N
R. 8 W.
R. 7 W.
(Joins sheet 2)
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 16)
T. 22 N.
15
14
13
18
22
23
24
19
HOUGHTON
LAKE
STATE
FOREST
B L O O M F I E L D
Ham
Creek
MOORESTOWN
MOREY
ROAD
1 770 000 FEET
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:15 840

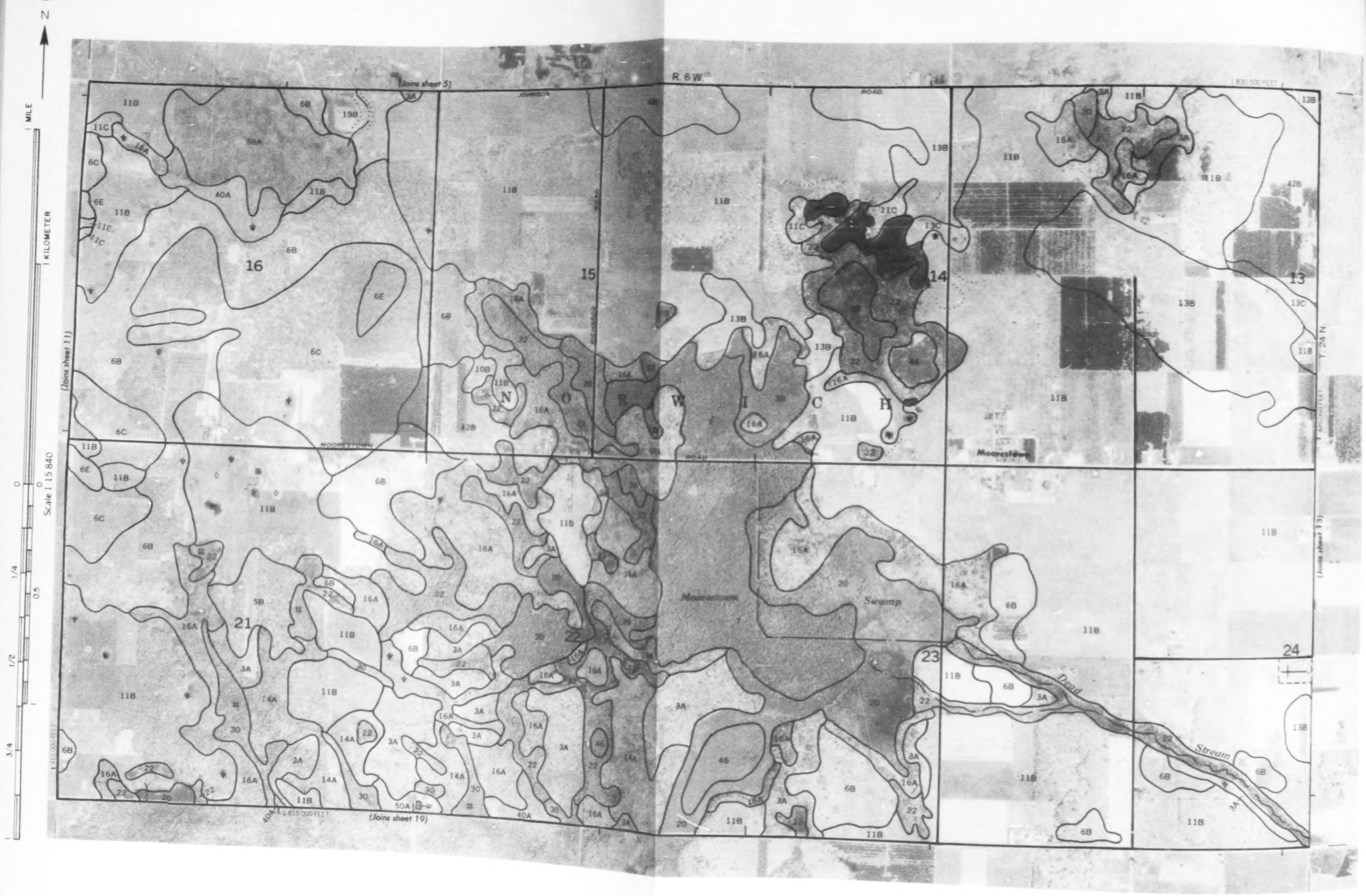
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 10


N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
(Joins sheet 3)
R. 7 W.
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 17)
17
16
15
14
20
21
22
23
HOUGHTON
LAKE
STATE
FOREST
P
I
O
N
E
E
R
MOORESTOWN
ROAD
VANDERMULLEN
ROAD
OLD 66
66
13B
13C
13E
11B
11C
11E
42B
42C
42E
14A
16A
20
22
3A
30
6C
6E
10B
10C
40A
2C

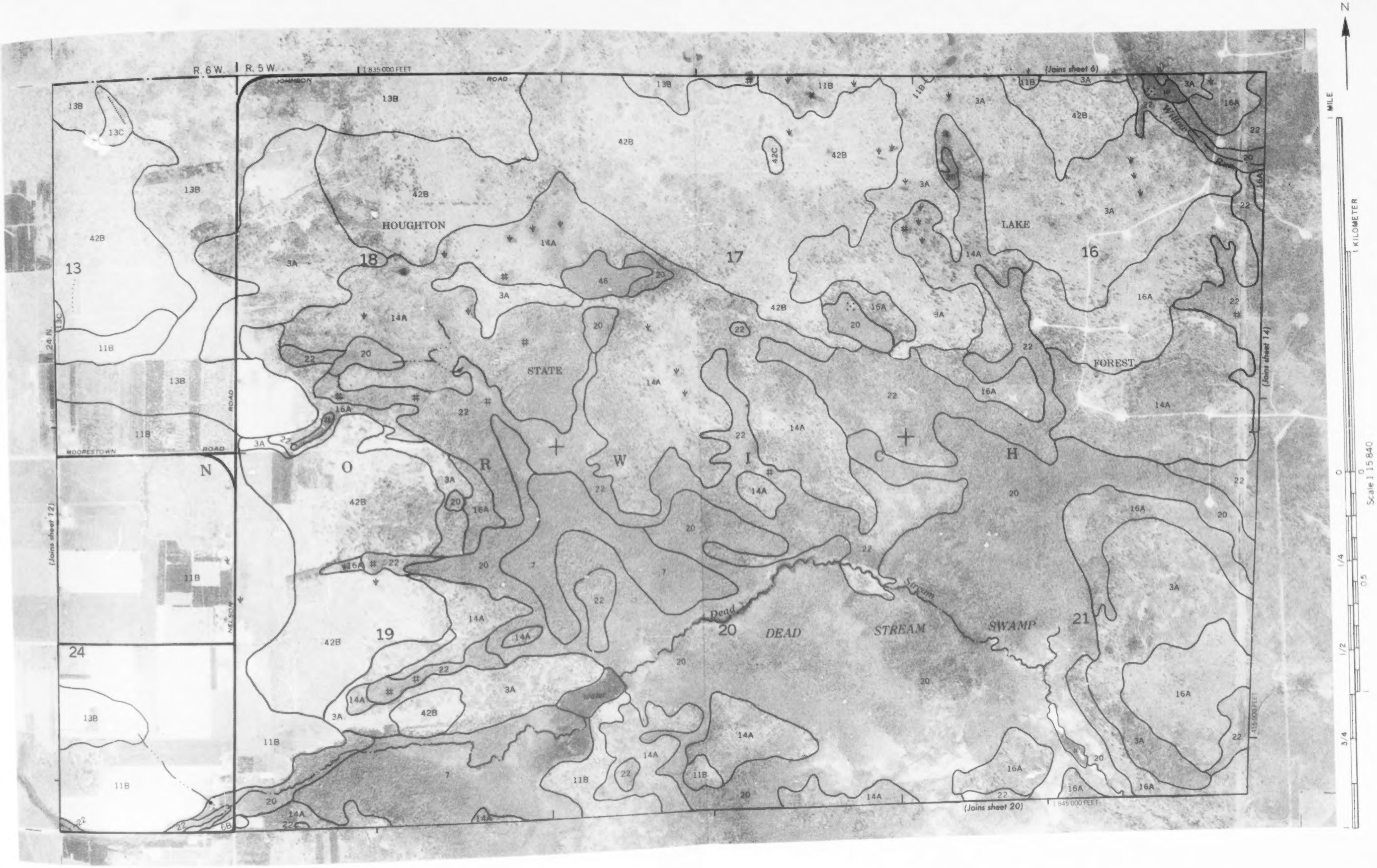
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 11


N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:15 840
(Joins sheet 4)
(Joins sheet 12)
(Joins sheet 10)
(Joins sheet 18)
1 790 000 FEET
1 810 000 FEET
415 000 FEET
T. 24 N.
R. 7 W.
R. 6 W.
HOUGHTON
LAKE
STATE
FOREST
N
O
R
W
I
C
H
MOORESTOWN
ROAD
7 MILE
13
14
17
18
19
20
23
24
11B
11C
11E
13B
13C
13E
15B
15E
42B
42C
42E
40A
6B
6C
6E
3A
14A
16A
20
22
37
50A
65
66
10B
12B
4B

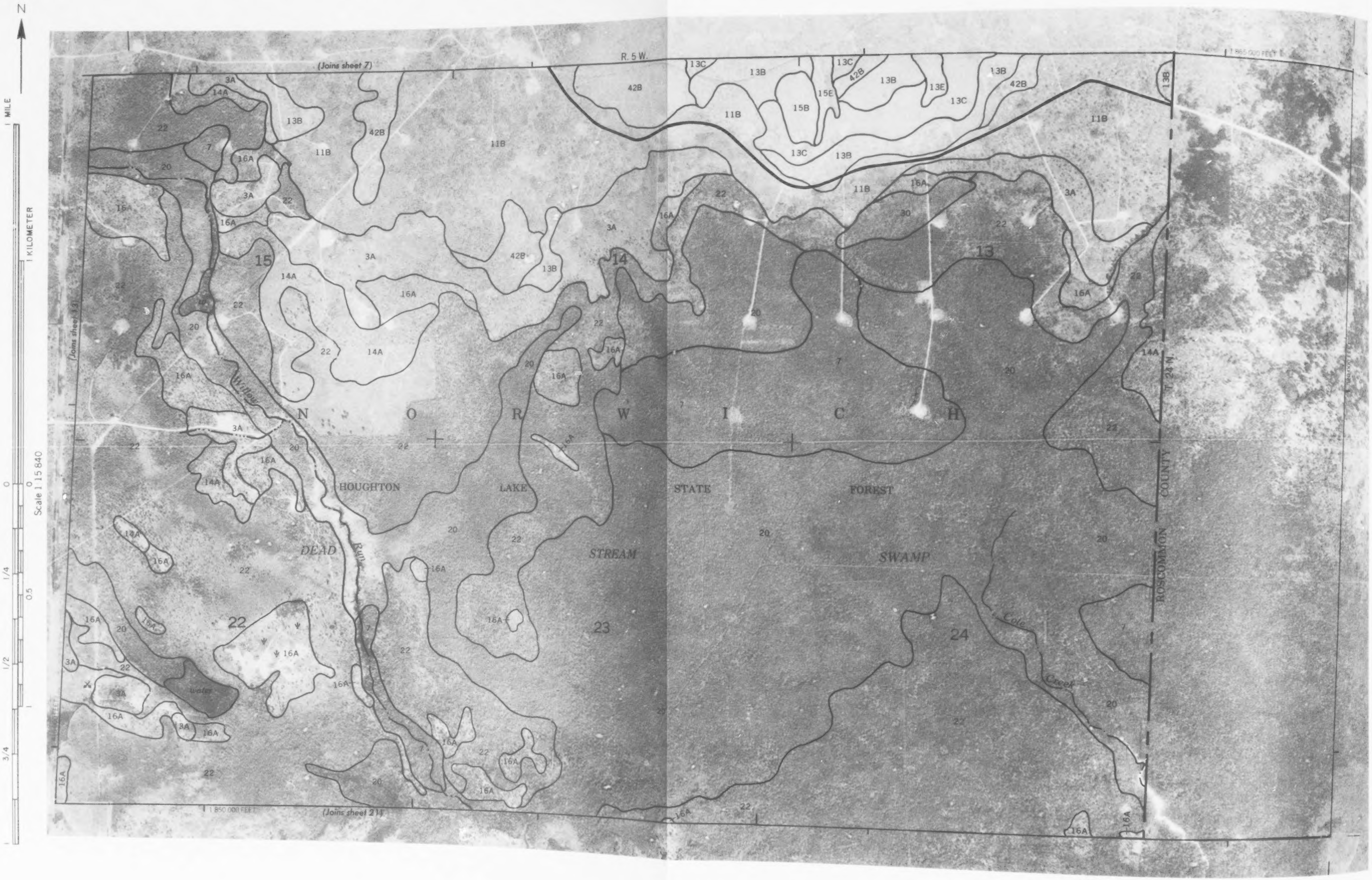
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 12

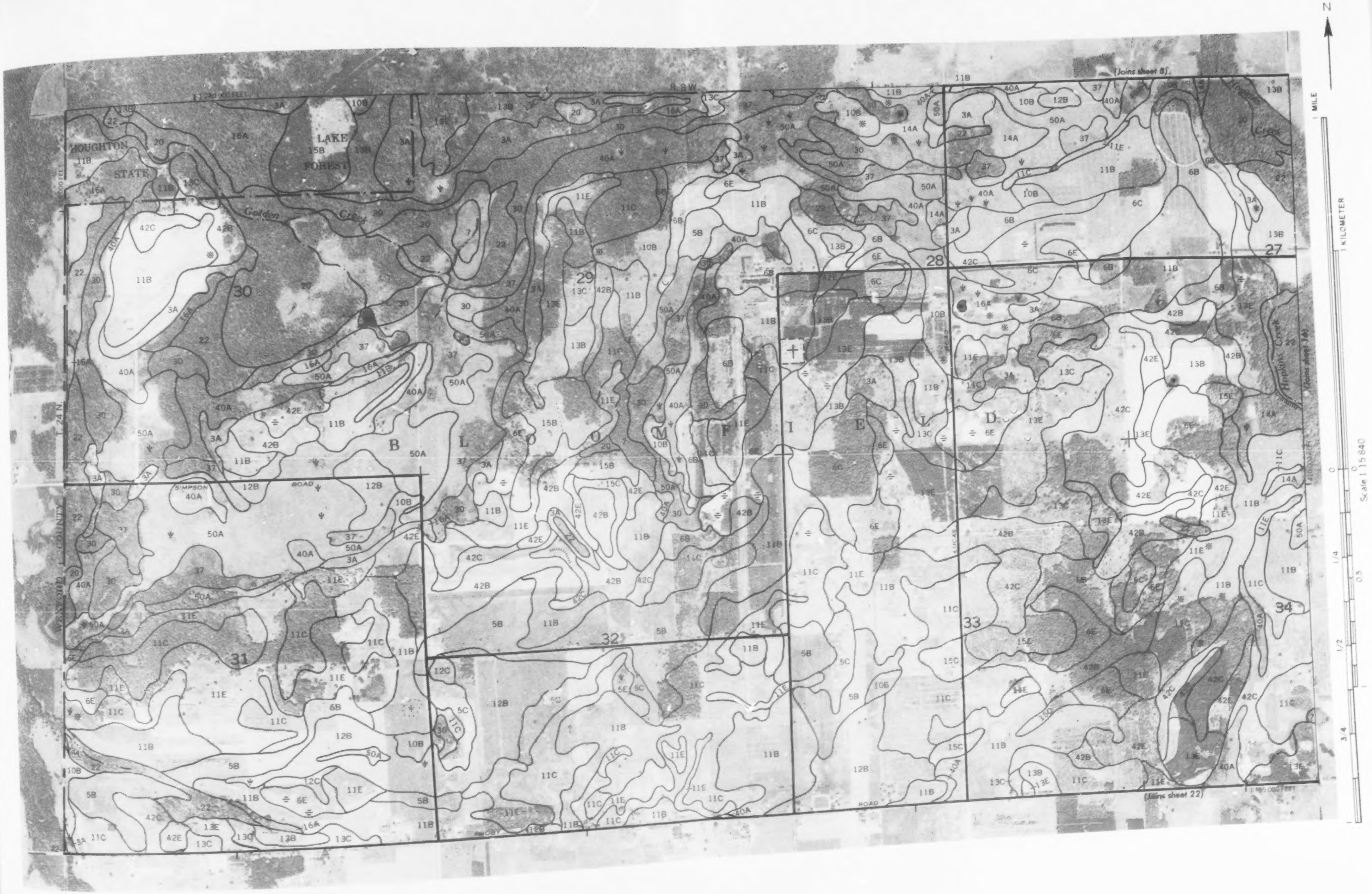

N
MILE
KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0.5
(Joins sheet 5)
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 19)
R. 6 W.
T. 24 N.
1 830 000 FEET
1 815 000 FEET
JOHNSON
ROAD
RICHARDS ROAD
MOORESTOWN
ROAD
Moorestown
Moorestown
Swamp
Dead
Stream
N O R W I C H
13
14
15
16
21
22
23
24
3A
5B
6B
6C
6E
10B
11B
11C
11E
13B
13C
14A
16A
20
22
30
40A
42B
46
50A
W

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 13

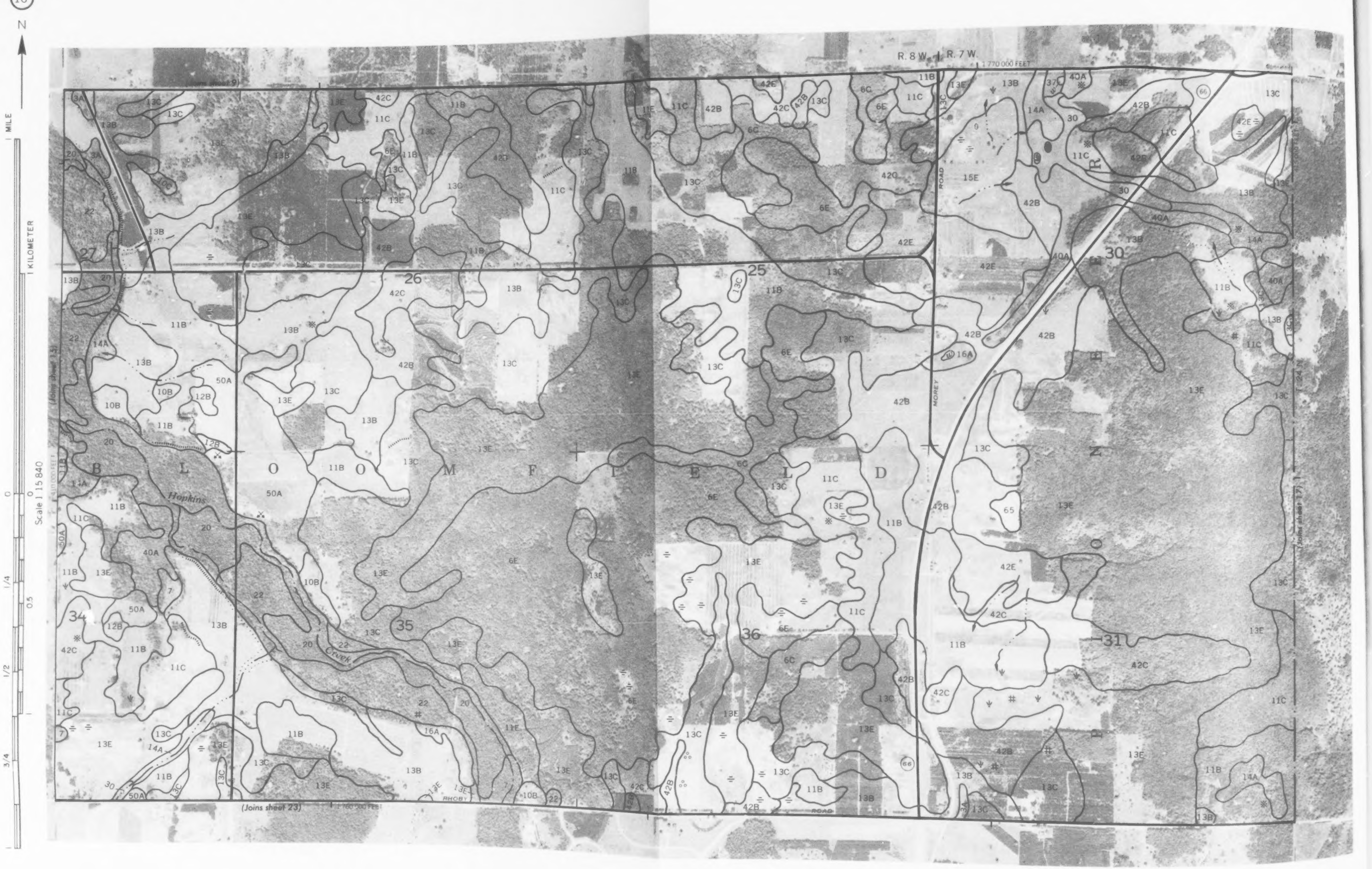

N
R. 6 W.
R. 5 W.
1 835 000 FEET
JOHNSON
ROAD
(Joins sheet 6)
(Joins sheet 12)
(Joins sheet 14)
(Joins sheet 20)
1 845 000 FEET
415 000 FEET
24 N.
MOORESTOWN
ROAD
NELSON
ROAD
HOUGHTON
LAKE
STATE
FOREST
N O R W I C H
DEAD STREAM SWAMP
Dead Stream
Willow Run
Water
13
18
17
16
19
20
21
24
13B
13C
42B
42C
11B
3A
14A
16A
20
22
46
7
6B
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:15 840

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 14

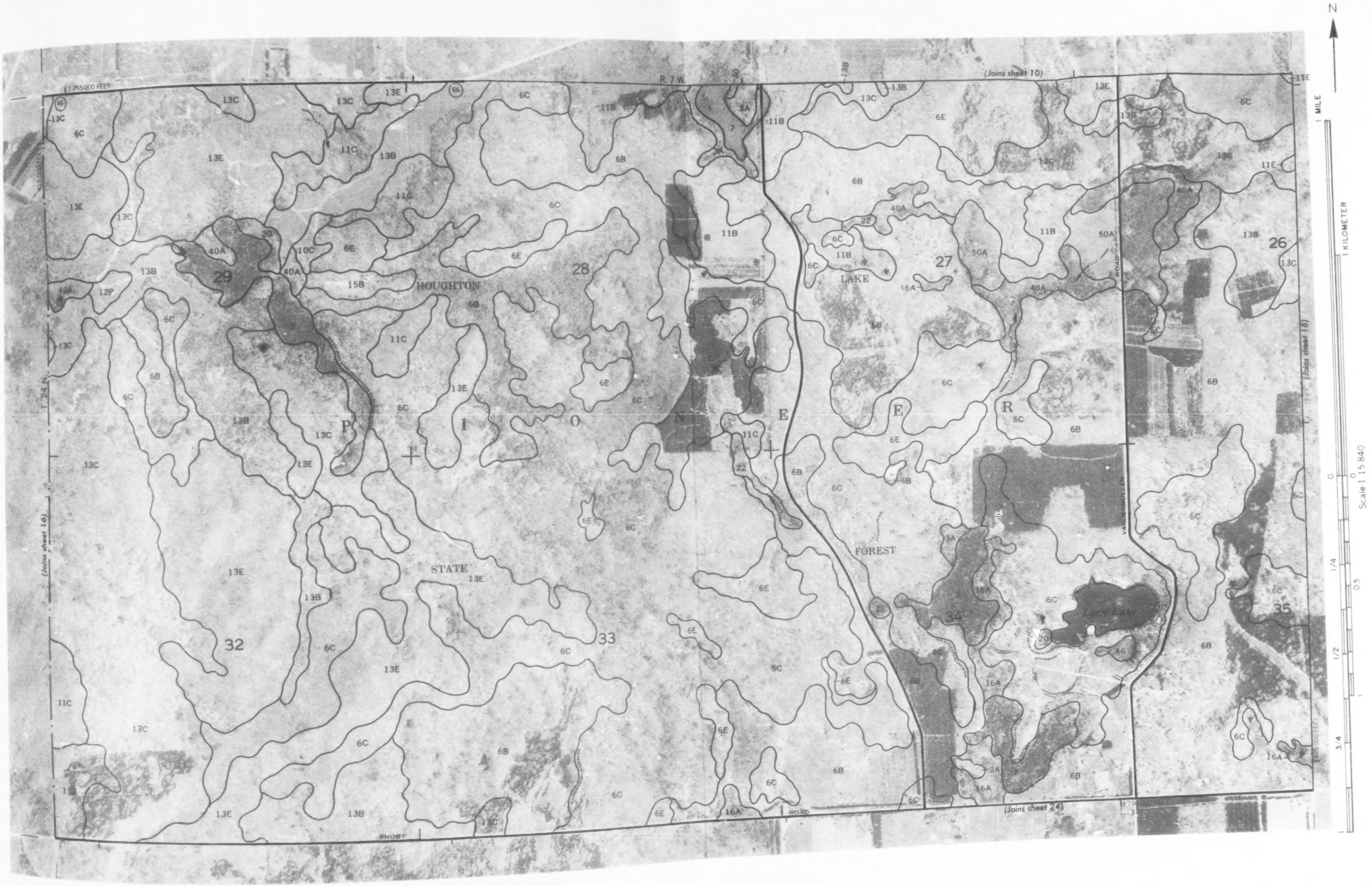

N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0
0.5
1
R. 5 W.
(Joins sheet 7)
(Joins sheet 13)
(Joins sheet 21)
1 850 000 FEET
1 865 000 FEET
T. 24 N.
ROSCOMMON COUNTY
NORWICH
HOUGHTON LAKE STATE FOREST
DEAD STREAM SWAMP
Willow
Dead Run
Cole Creek
water
13
14
15
22
23
24
3A
7
11B
13B
13C
13E
14A
15B
15E
16A
20
22
30
42B


(Joins sheet 8)
(Joins sheet 22)
(Joins sheet 16)
R. 8 W.
T. 24 N.
WEXFORD COUNTY
HOUGHTON LAKE STATE FOREST
Golden Creek
Hopkins Creek
B L O O M F I E L D
SIMPSON ROAD
LUCAS ROAD
MOBY ROAD
ROAD
27
28
29
30
31
32
33
34
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5

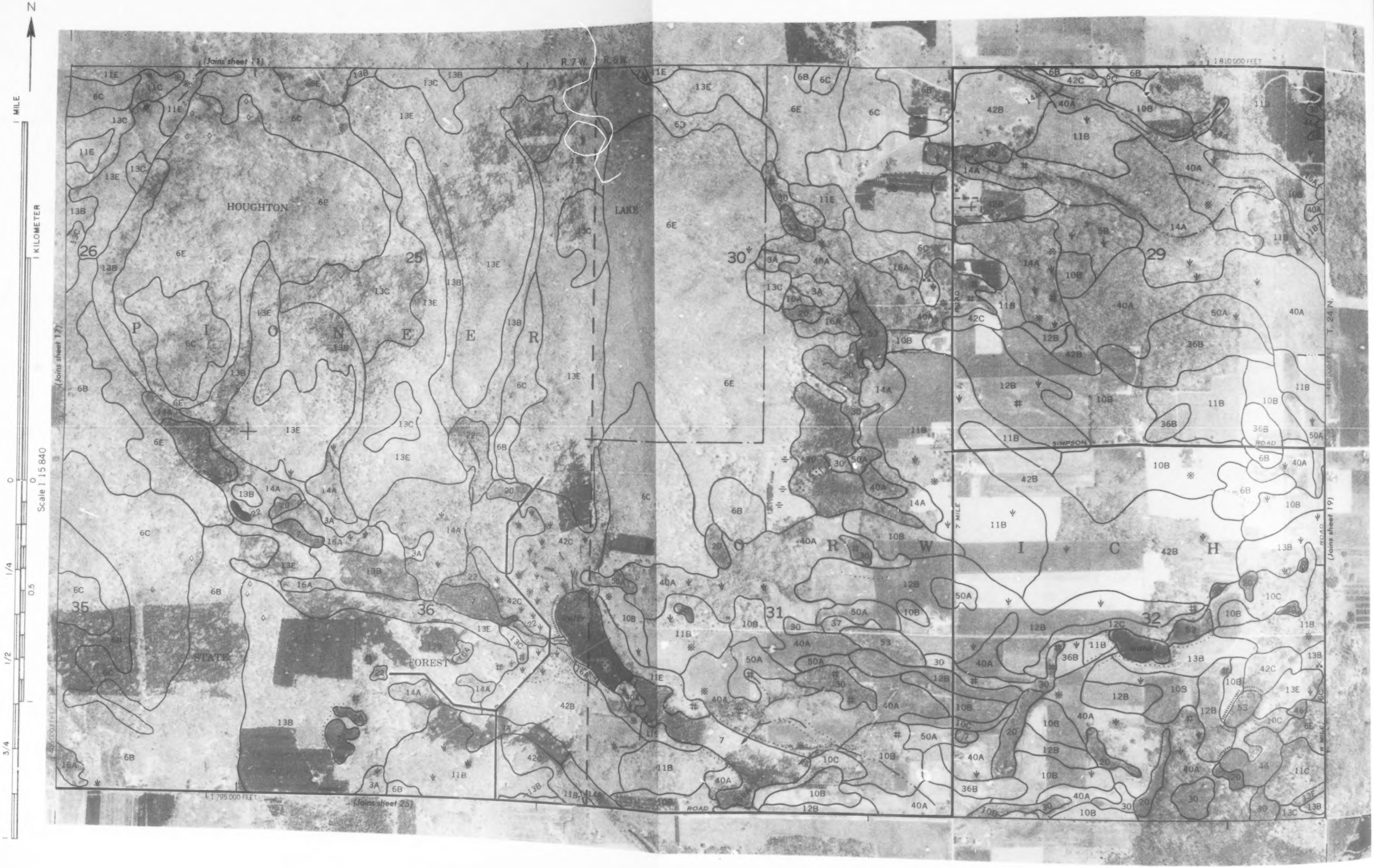
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 16

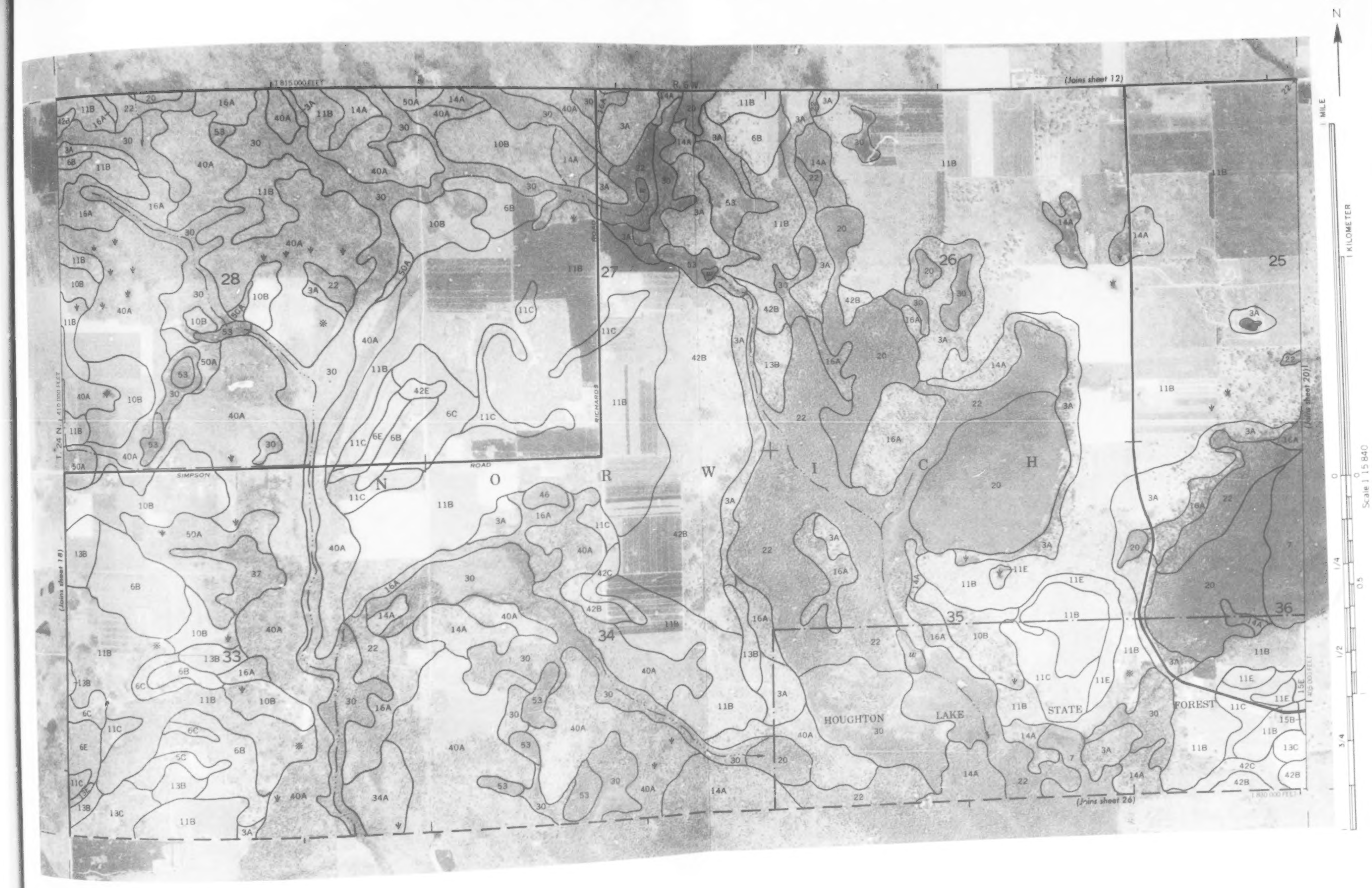

16
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0
0.5
R. 8 W.
R. 7 W.
1 770 000 FEET
(Joins sheet 9)
(Joins sheet 15)
(Joins sheet 17)
(Joins sheet 23)
1 760 000 FEET
B L O O M F I E L D
P I O N E E R
25
26
27
30
31
34
35
36
Hopkins
Creek
MOREY ROAD
RHOBY
ROAD
66

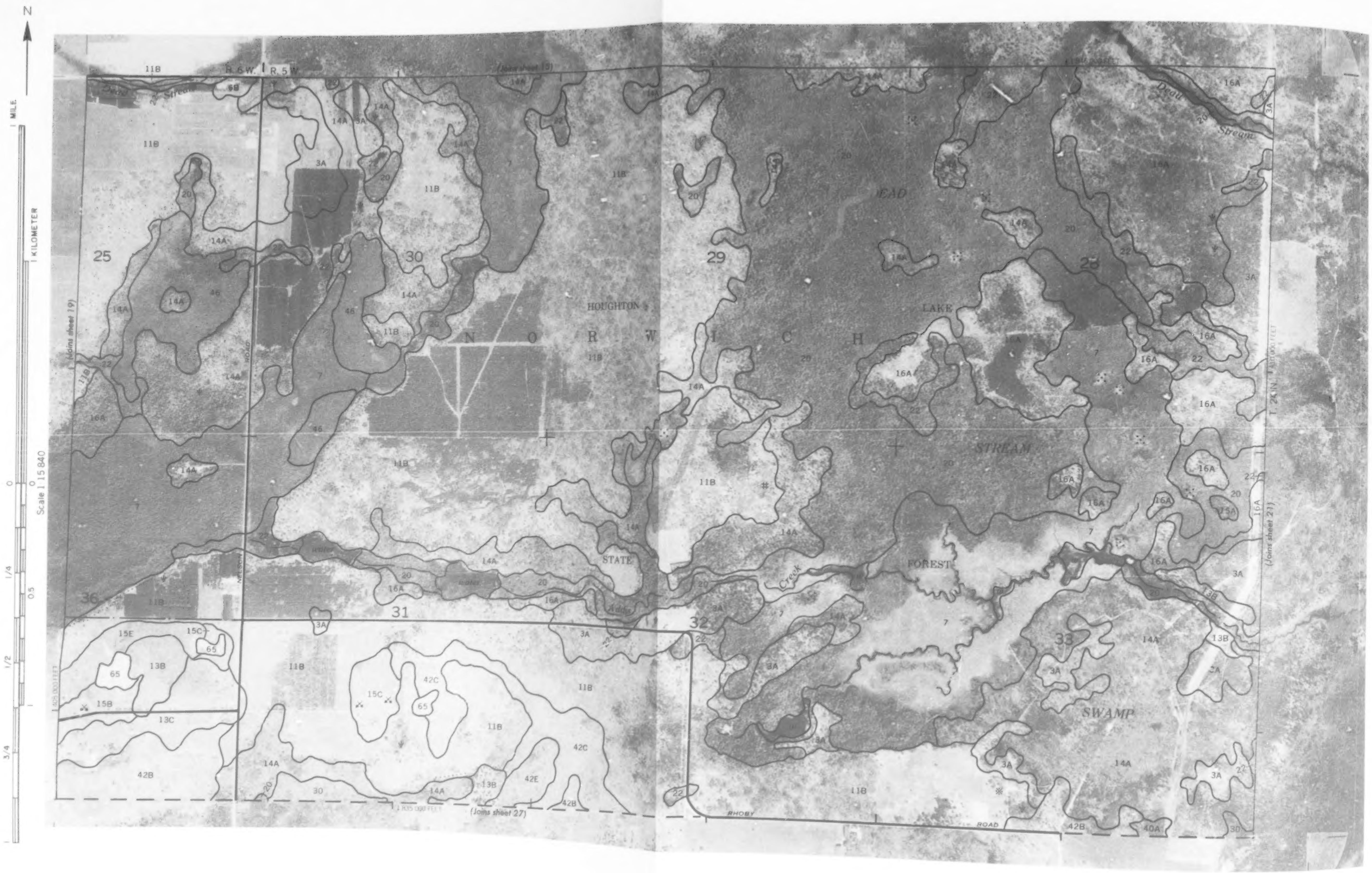
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 17


(Joins sheet 10)
(Joins sheet 16)
(Joins sheet 18)
(Joins sheet 24)
R. 7 W.
T. 24 N.
1 755 000 FEET
HOUGHTON LAKE
PIONEER STATE FOREST
Loon Lake
SHOBY ROAD
ROAD
VANDERMUELEN RD.
26
27
28
29
32
33
34
35
66
3A
6B
6C
6E
7
10C
11B
11C
11E
12P
13B
13C
13E
15B
16A
20
22
40A
46
50A
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0.5
1

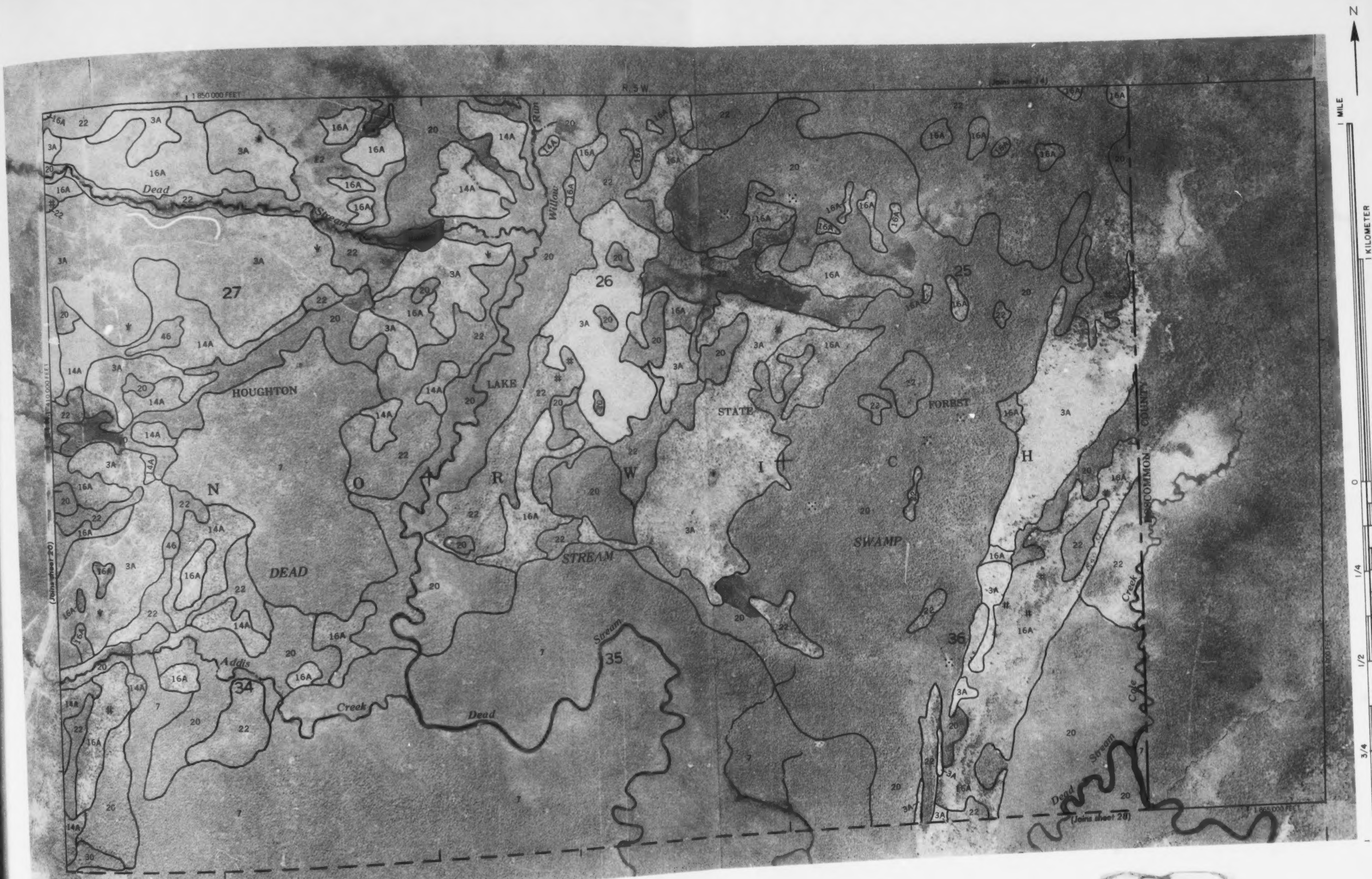
⑱


N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
0.5
1/2
3/4
1
(Joins sheet 11)
R.7W.
R.6W.
1 810 000 FEET
HOUGHTON
LAKE
P I O N E E R
O R W I C H
STATE
FOREST
26
25
30
29
35
36
31
32
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 25)
T. 24 N.
1 795 000 FEET
SIMPSON ROAD
7 MILE ROAD
ROAD


(Joins sheet 12)
(Joins sheet 18)
(Joins sheet 20)
(Joins sheet 26)
R. 6 W.
T. 24 N.
NORWICH
HOUGHTON LAKE STATE FOREST
SIMPSON ROAD
RICHARDS ROAD
25
26
27
28
33
34
35
36
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0
0.5
Scale 1:15 840

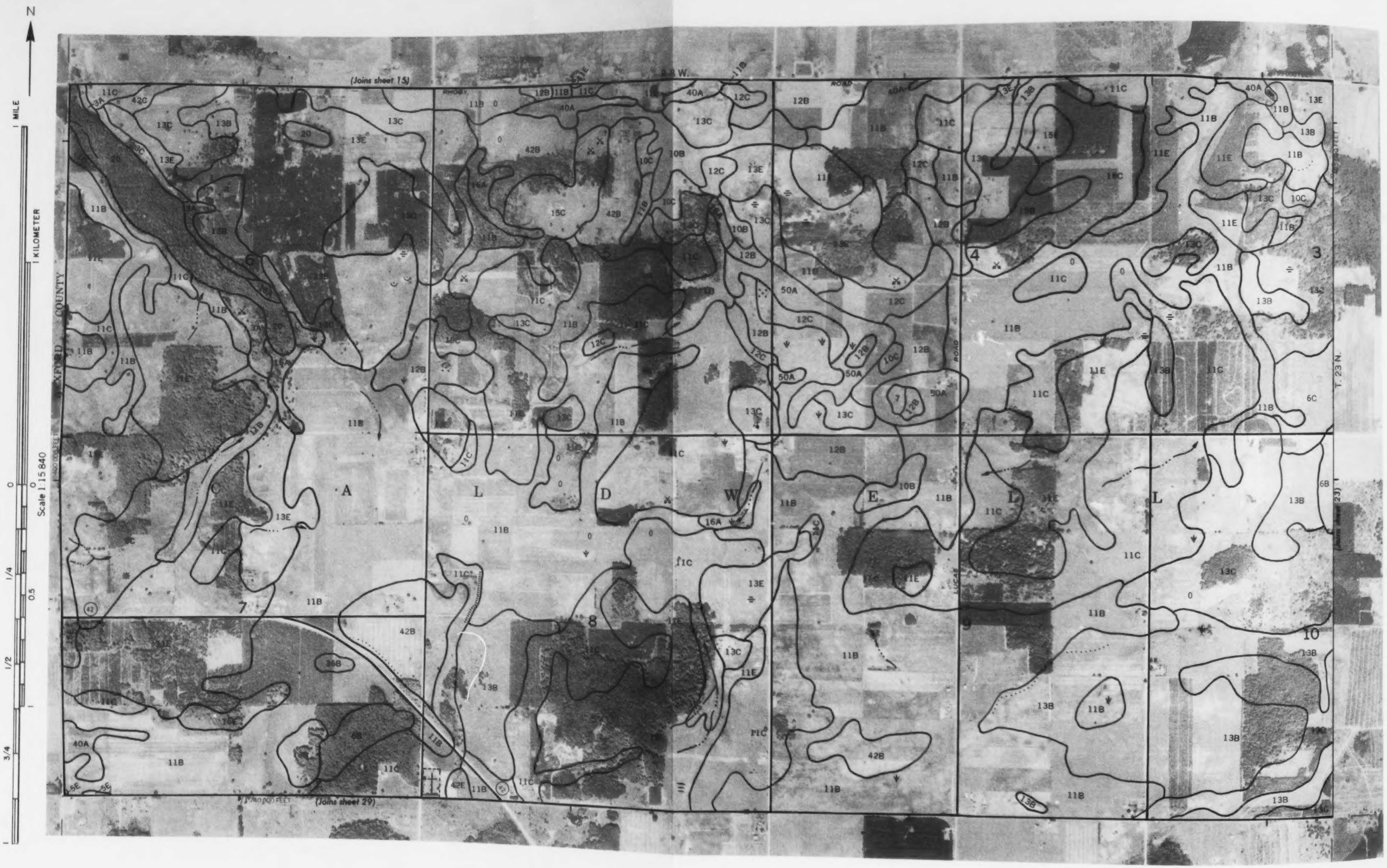

N
MILE
KILOMETER
0
1/4
1/2
3/4
0
0.5
1
Scale 1:15 840
R. 6 W.
R. 5 W.
(Joins sheet 19)
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 27)
T. 24 N.
25
30
29
28
36
31
32
33
Dead Stream
Dead Stream
NORWICH
HOUGHTON LAKE STATE FOREST
DEAD STREAM SWAMP
Addis Creek
NELSON ROAD
RHOBY ROAD
water
11B
14A
16A
3A
20
22
7
46
13B
13C
15B
15C
15E
42B
42C
42E
40A
30
65

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 21

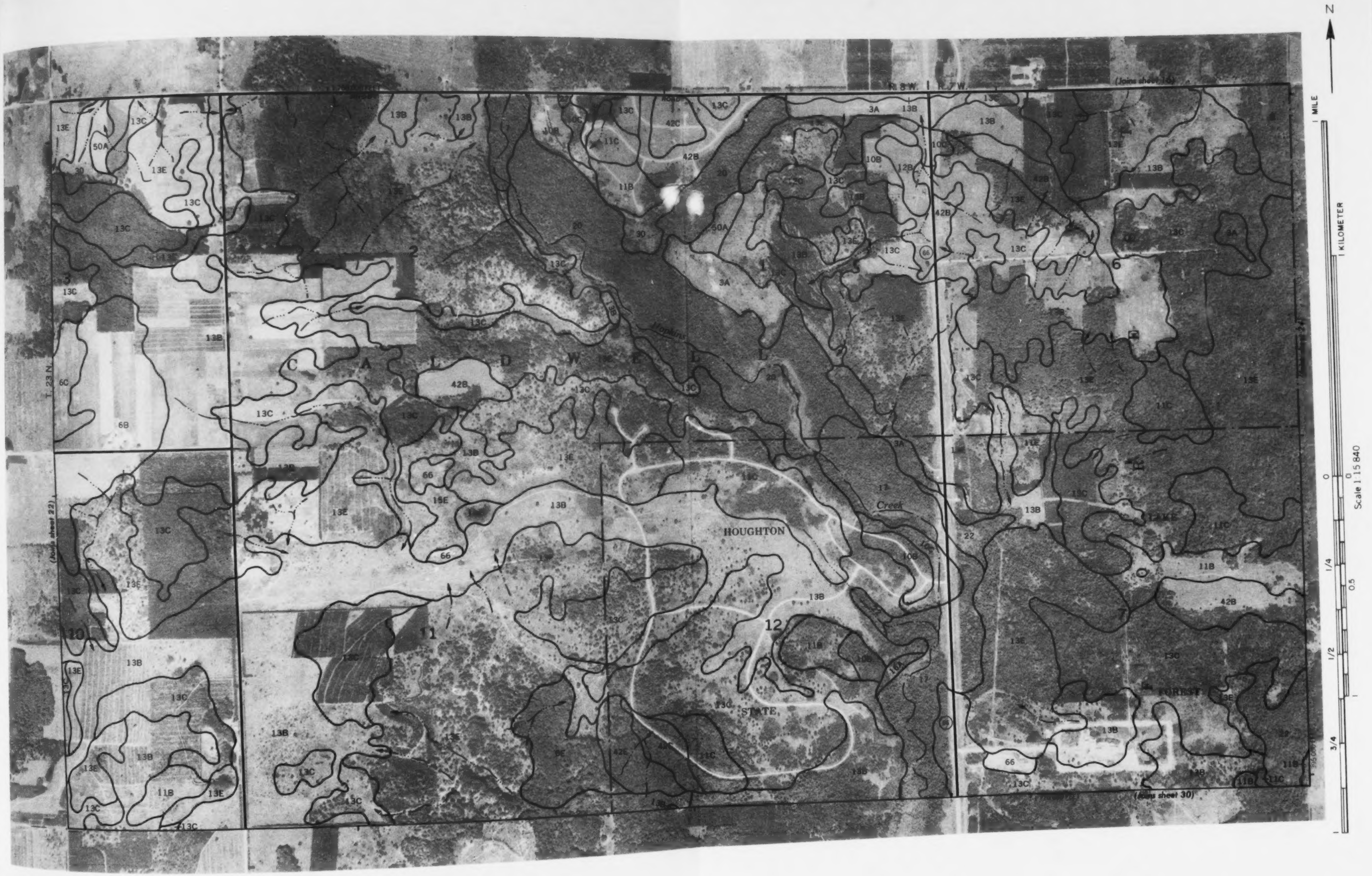

N
R. 5 W.
1 850 000 FEET
(Joins sheet 14)
(Joins sheet 20)
(Joins sheet 28)
Dead Stream
Willow Run
HOUGHTON LAKE STATE FORREST
N O R W I C H
DEAD STREAM SWAMP
Addis Creek
Cole Creek
ROSCOMMON COUNTY
25
26
27
34
35
36
3A
7
14A
16A
20
22
30
46
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1

㉒

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 22

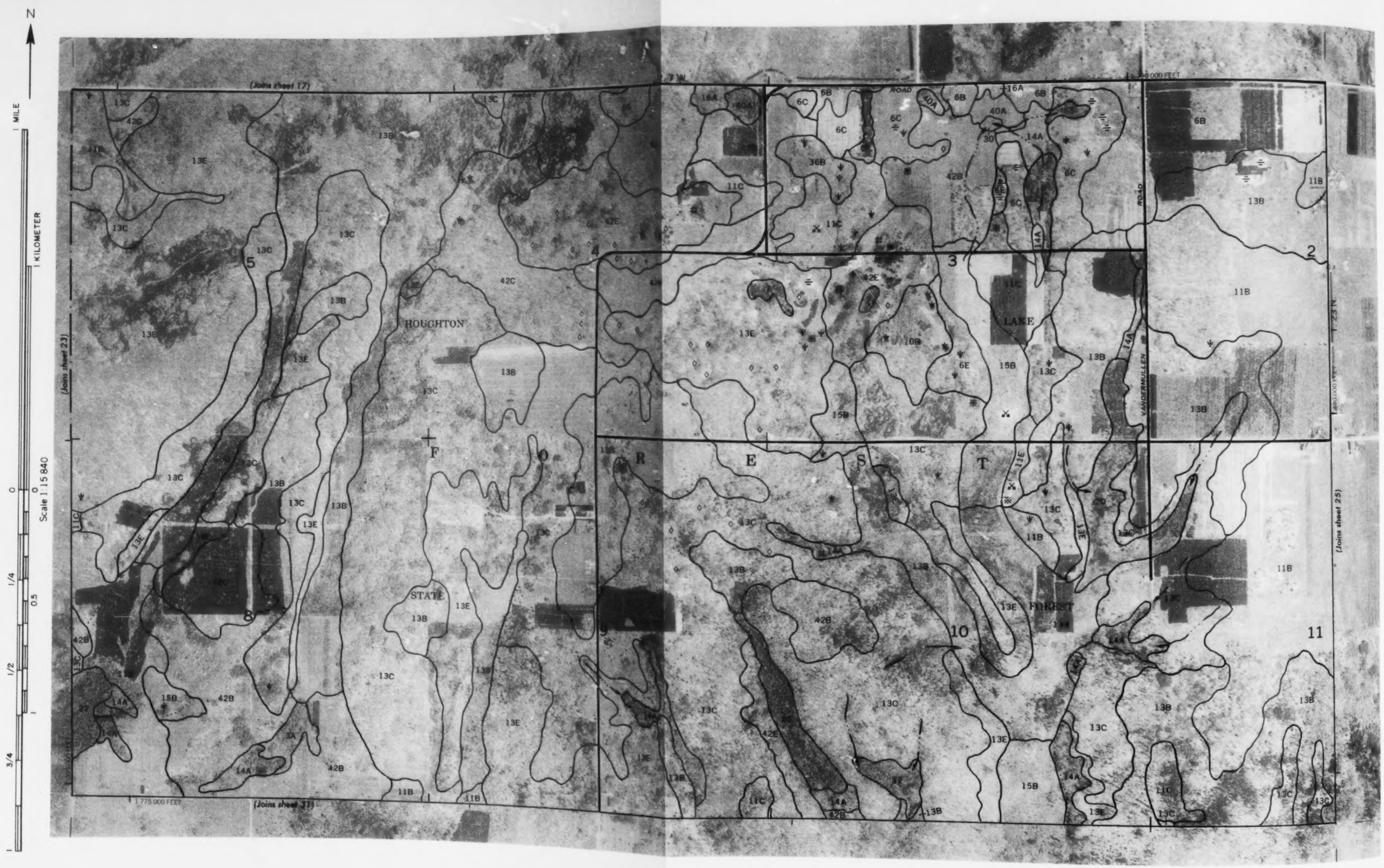

N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0.5
(Joins sheet 15)
(Joins sheet 29)
(Joins sheet 23)
R. 8 W.
T. 23 N.
WEXFORD COUNTY
ROAD
LUCAS ROAD
A
L
D
W
E
L
L
C
3
4
6
7
8
9
10
11B
11C
11E
12B
12C
13B
13C
13E
10B
10C
15C
16A
20
3A
40A
42B
42C
42E
50A
36B
6B
6C
5E
0

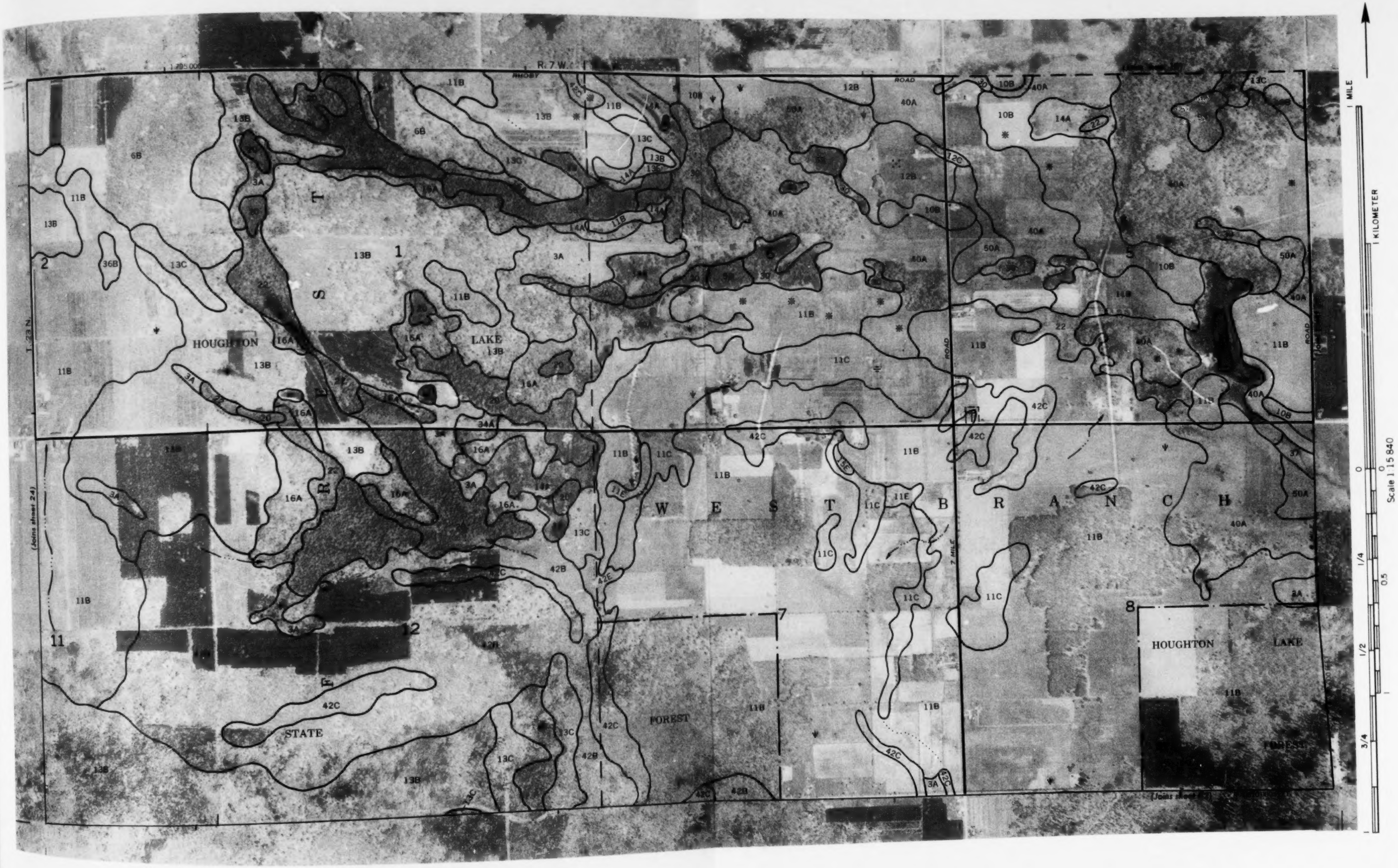
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 23


N
(Joins sheet 16)
(Joins sheet 22)
(Joins sheet 30)
R. 8 W.
R. 7 W.
T. 23 N.
C A L D W E L L
HOUGHTON
LAKE
STATE
FOREST
Hopkins
Creek
1
2
3
6
10
11
12
13B
13C
13E
11B
11C
10B
10C
12B
42B
42C
50A
3A
6B
6C
20
22
30
66
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:15 840

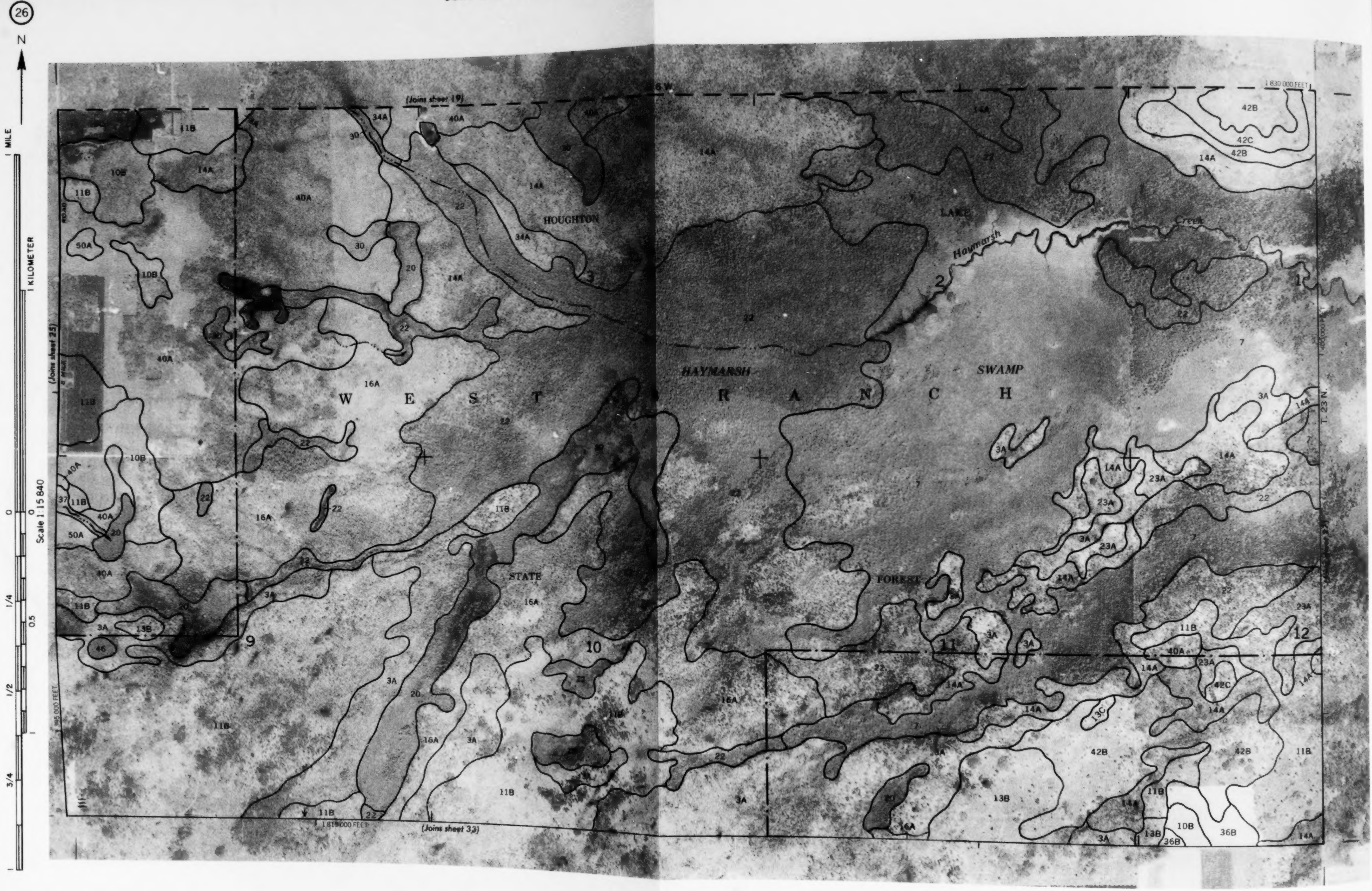
㉔

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 24


N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 17)
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 31)
1 775 000 FEET
480 000 FEET
T. 23 N.
R. 7 W.
HOUGHTON
LAKE
STATE
FOREST
F
O
R
E
S
T
ROAD
VANDERMULLEN
2
3
4
5
8
9
10
11
13C
42C
11B
13E
13B
42E
6B
6C
16A
40A
36B
11C
42B
14A
30
15B
10B
6E
22
3A
12

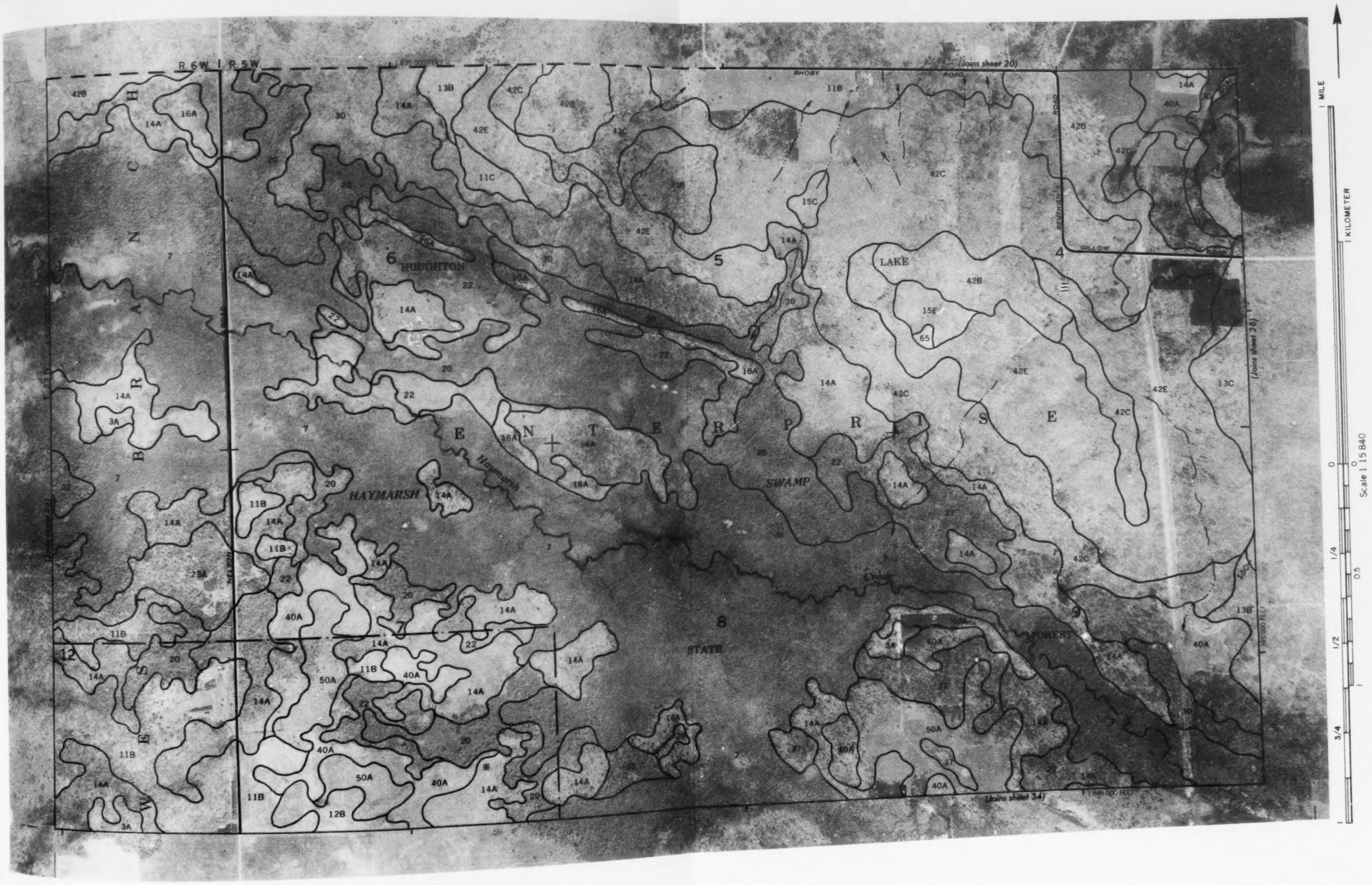

N
R. 7 W.
T. 23 N.
RHOBY
ROAD
7 MILE
(Joins sheet 24)
HOUGHTON LAKE STATE FOREST
WEST BRANCH
HOUGHTON LAKE
FOREST
1
2
5
6
7
8
11
12
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0.5
3A
6B
10B
11B
11C
11E
12B
12C
13B
13C
13E
14A
16A
20
22
34A
36B
37
40A
42B
42C
42E
50A

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 26

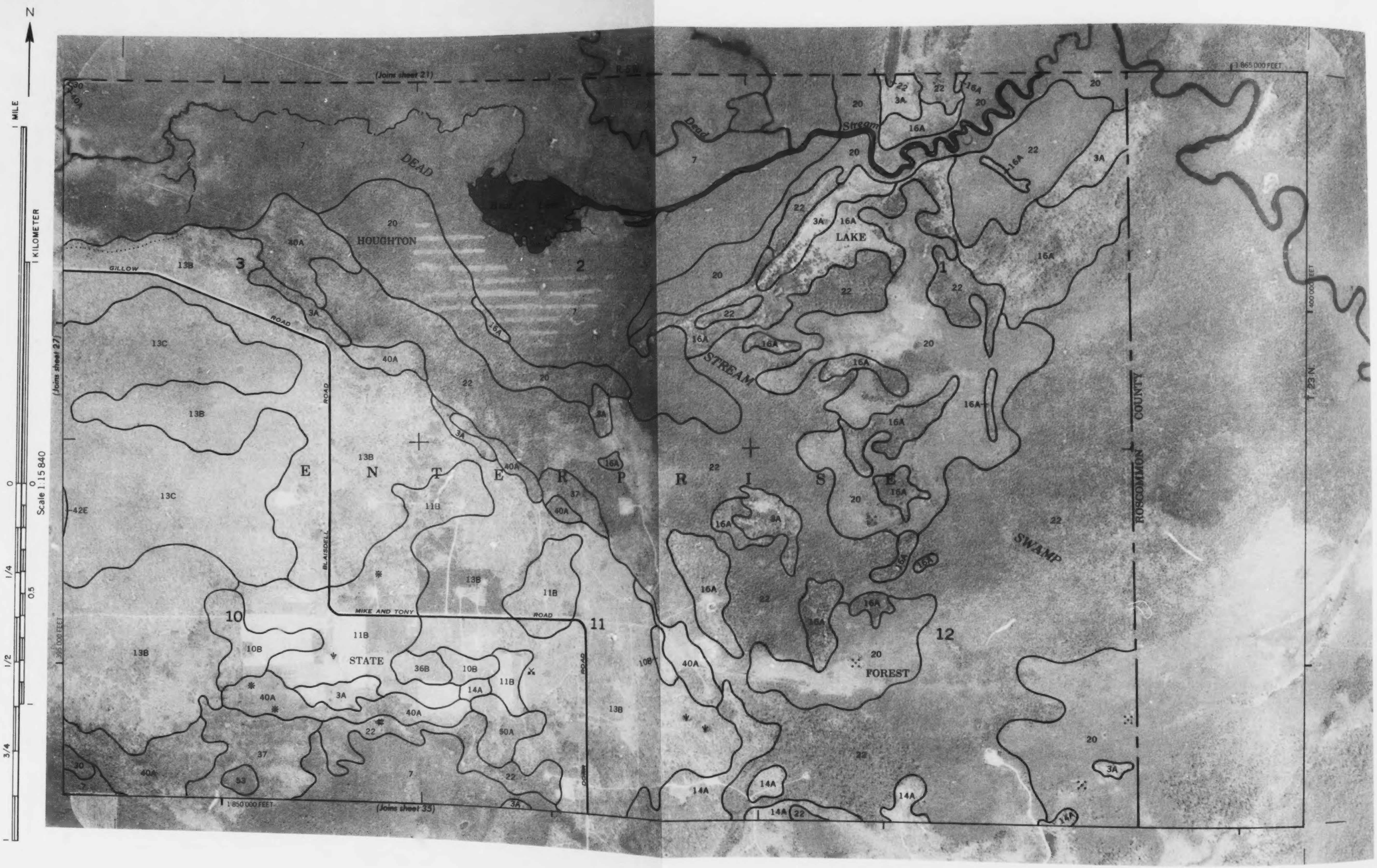


26
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0
0.5
Scale 1:15 840
(Joins sheet 19)
(Joins sheet 25)
(Joins sheet 33)
R. 6 W.
T. 23 N.
1 830 000 FEET
1 819 000 FEET
386 000 FEET
ROAD
HOUGHTON
LAKE
Haymarsh
Creek
HAYMARSH
SWAMP
W E S T B R A N C H
STATE
FOREST
1
2
3
9
10
11
12
3A
7
10B
11B
13B
13C
14A
16A
20
22
23A
30
34A
36B
37
40A
42B
42C
46
50A

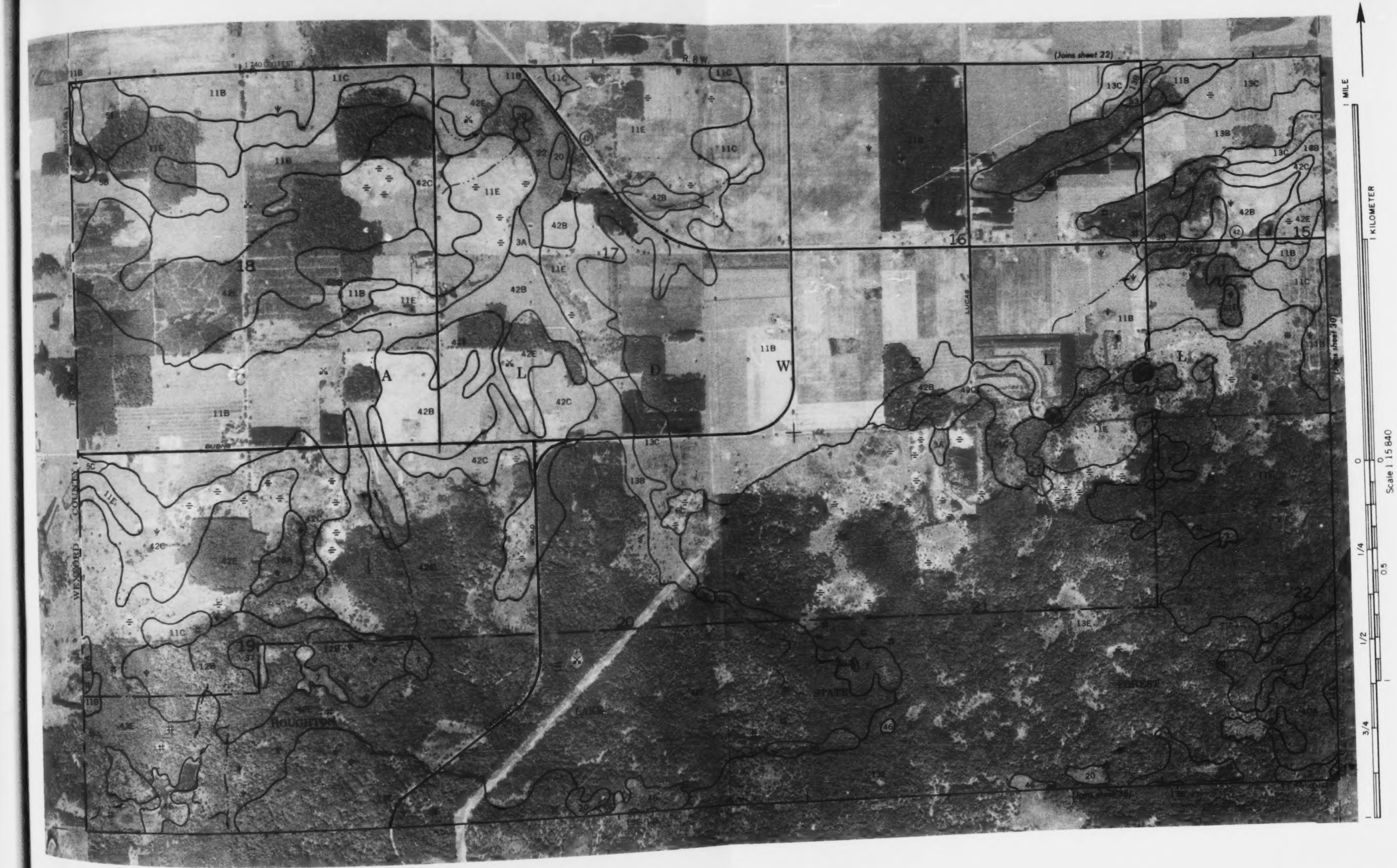
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 27


N
R.6W.
R.5W.
(Joins sheet 20)
(Joins sheet 28)
(Joins sheet 34)
RHOBY ROAD
GILLOW ROAD
NELSON ROAD
HOUGHTON
LAKE
HAYMARSH
Haymarsh
SWAMP
STATE
FOREST
Creek
B R A N C H
E N T E R P R I S E
W E S
6
5
4
7
8
9
12
42B
16A
14A
13B
30
42C
42E
11C
11B
15C
20
22
3A
23A
40A
50A
12B
37
15E
65
13C
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:15 840

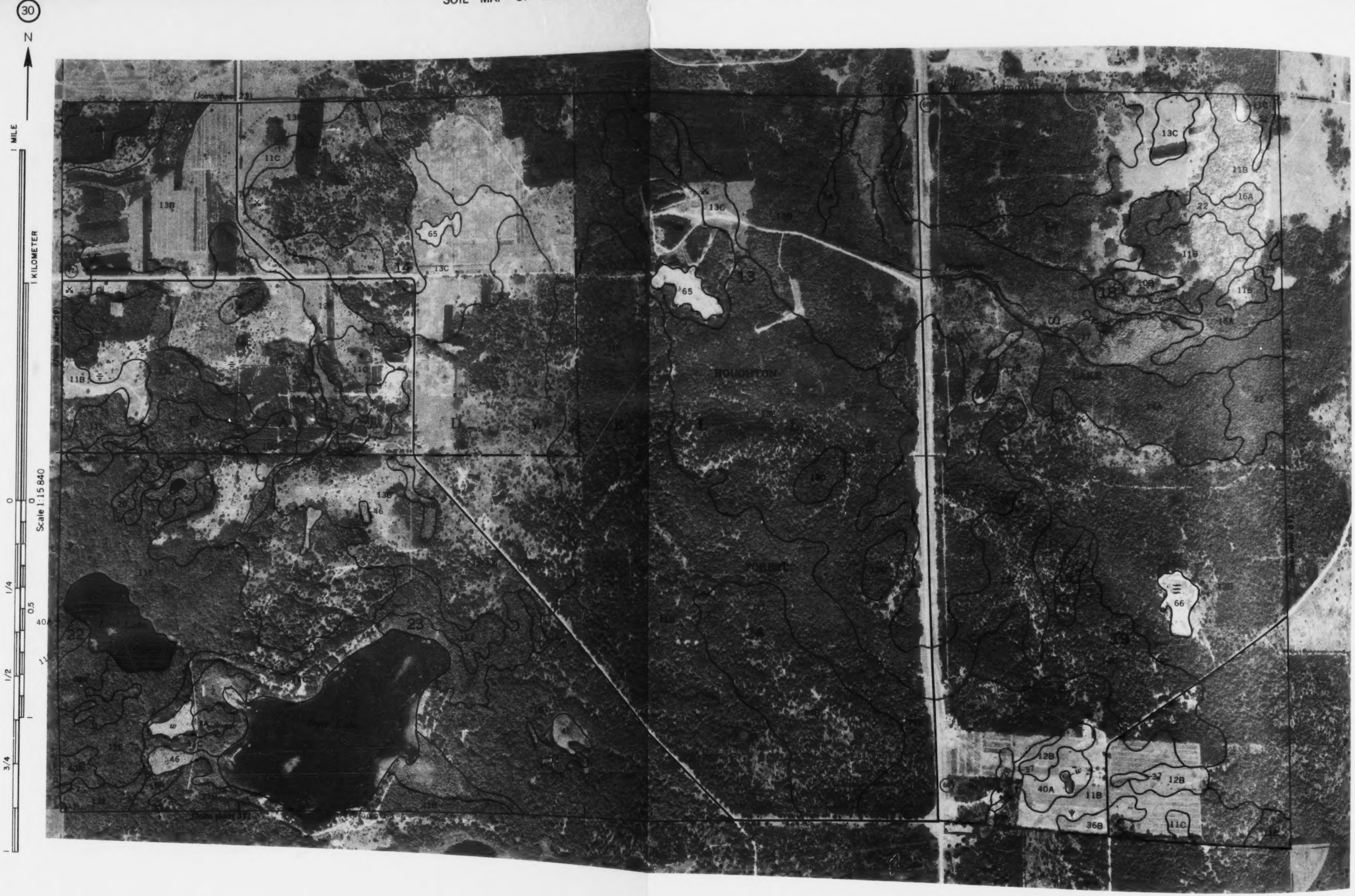
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 28

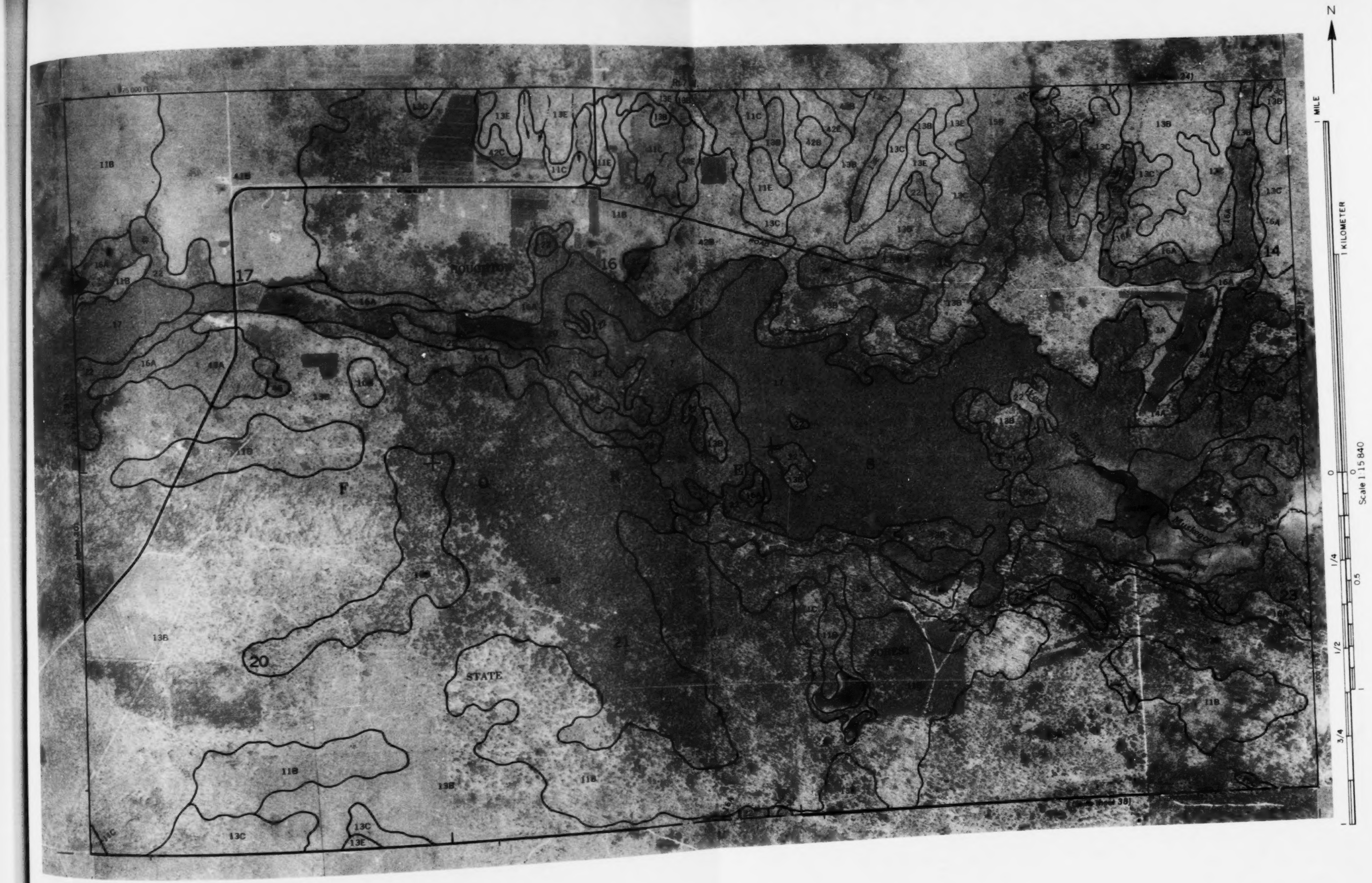

N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
0.5
1/2
3/4
1
(Joins sheet 21)
(Joins sheet 27)
(Joins sheet 35)
R. 5 W.
T. 23 N.
1 865 000 FEET
1 850 000 FEET
395 000 FEET
400 000 FEET
DEAD
Dead
Stream
HOUGHTON
LAKE
STREAM
E N T E R P R I S E
SWAMP
STATE
FOREST
ROSCOMMON COUNTY
GILLOW ROAD
BLAISDELL ROAD
MIKE AND TONY ROAD
ROAD
1
2
3
10
11
12
7
13B
13C
40A
20
3A
16A
22
42E
11B
10B
36B
14A
50A
37
53
30
10B
22
3A
20
16A
14A

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 29

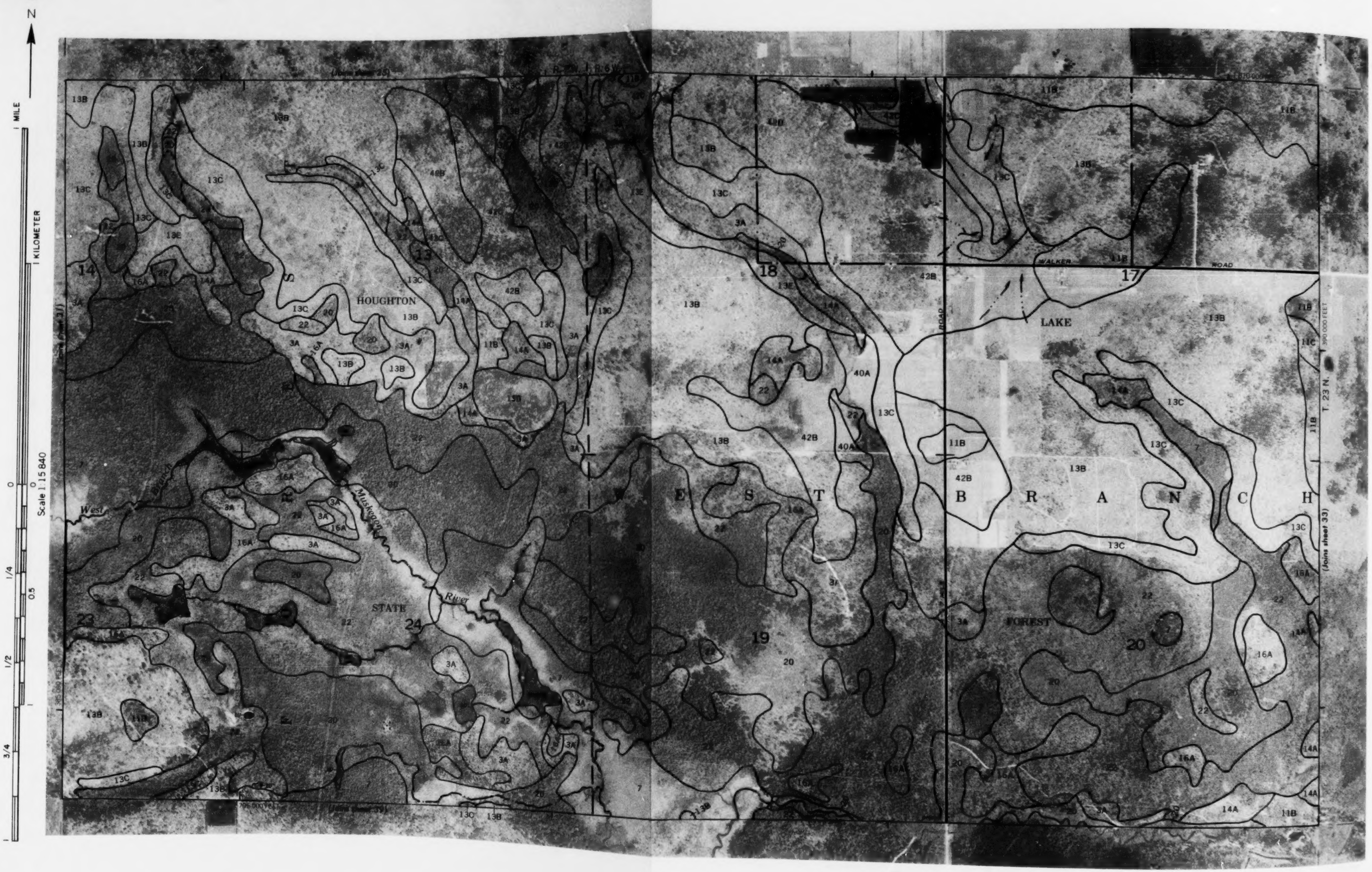

(Joins sheet 22)
R. 8 W.
1 740 000 FEET
11B
11C
11E
13B
13C
13E
3A
5C
5B
20
22
30
42
42B
42C
42E
46
7
15
16
17
18
19
20
21
22
C A L D W E L L
BURNS
LUCAS
WEXFORD COUNTY
HOUGHTON LAKE STATE FOREST
(Joins sheet 30)
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0.5

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 30

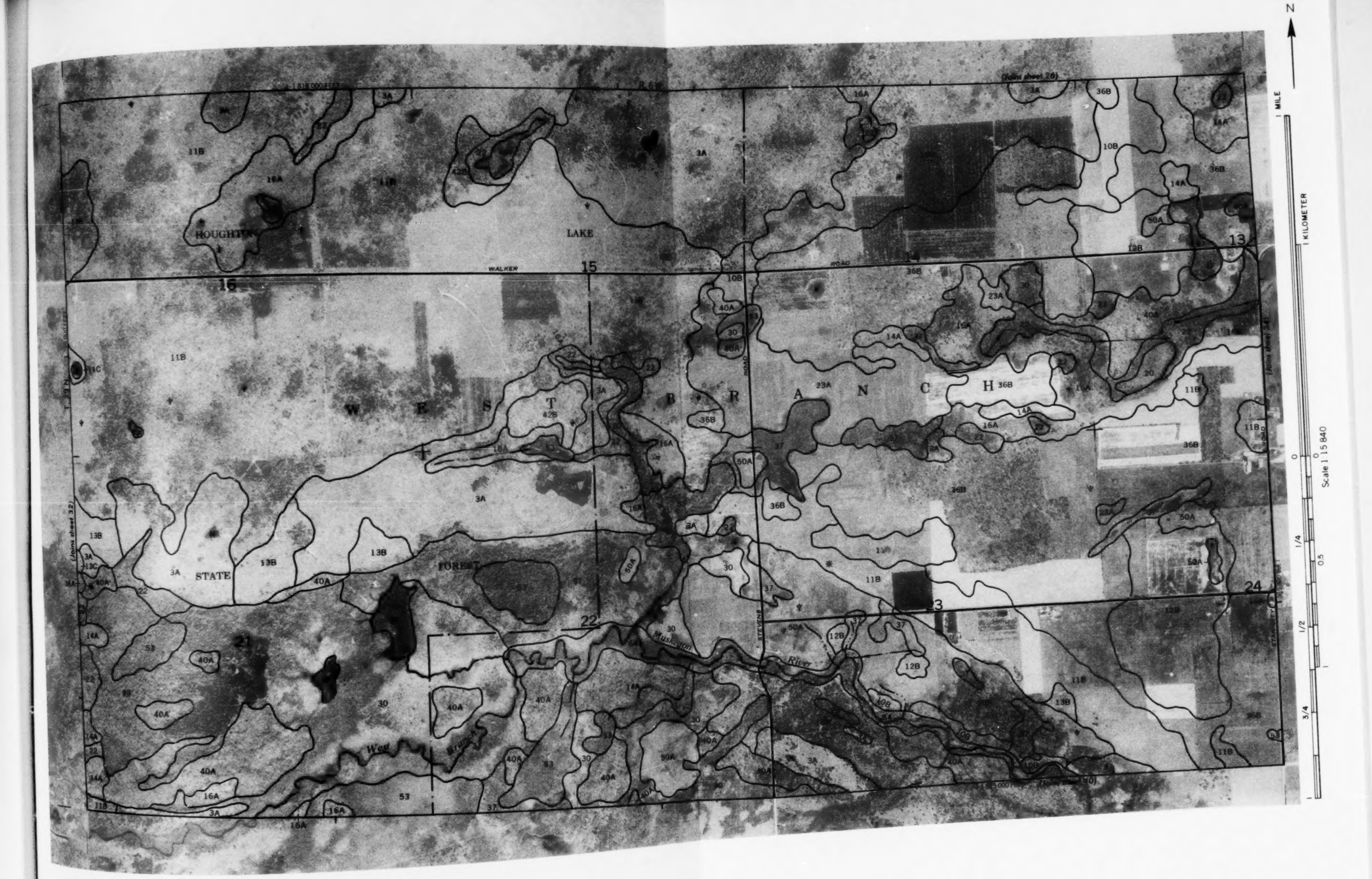

30
N
1 MILE
KILOMETER
0
1/4
1/2
3/4
1
0
0.5
1
Scale 1:15 840
(Joins sheet 23)
(Joins sheet 31)
13B
11C
13C
65
14
13
HOUGHTON
LAKE
FOREST
D
W
E
L
24
23
22
19
18
13C
11B
22
16A
10B
11B
16A
22
66
12B
37
40A
11B
36B
11C
12B
37
46
46
11B
40A
11C
w
w


11B
42B
13E
42C
11C
11E
13B
11C
42B
42E
13C
16A
11B
26
17
16A
42A
13B
16B
11B
F
HOUGHTON
16
17
ROAD
14
3A
14A
13B
20
STATE
11B
13C
13E
21
FOREST
Muskegon
23
22
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:15 840

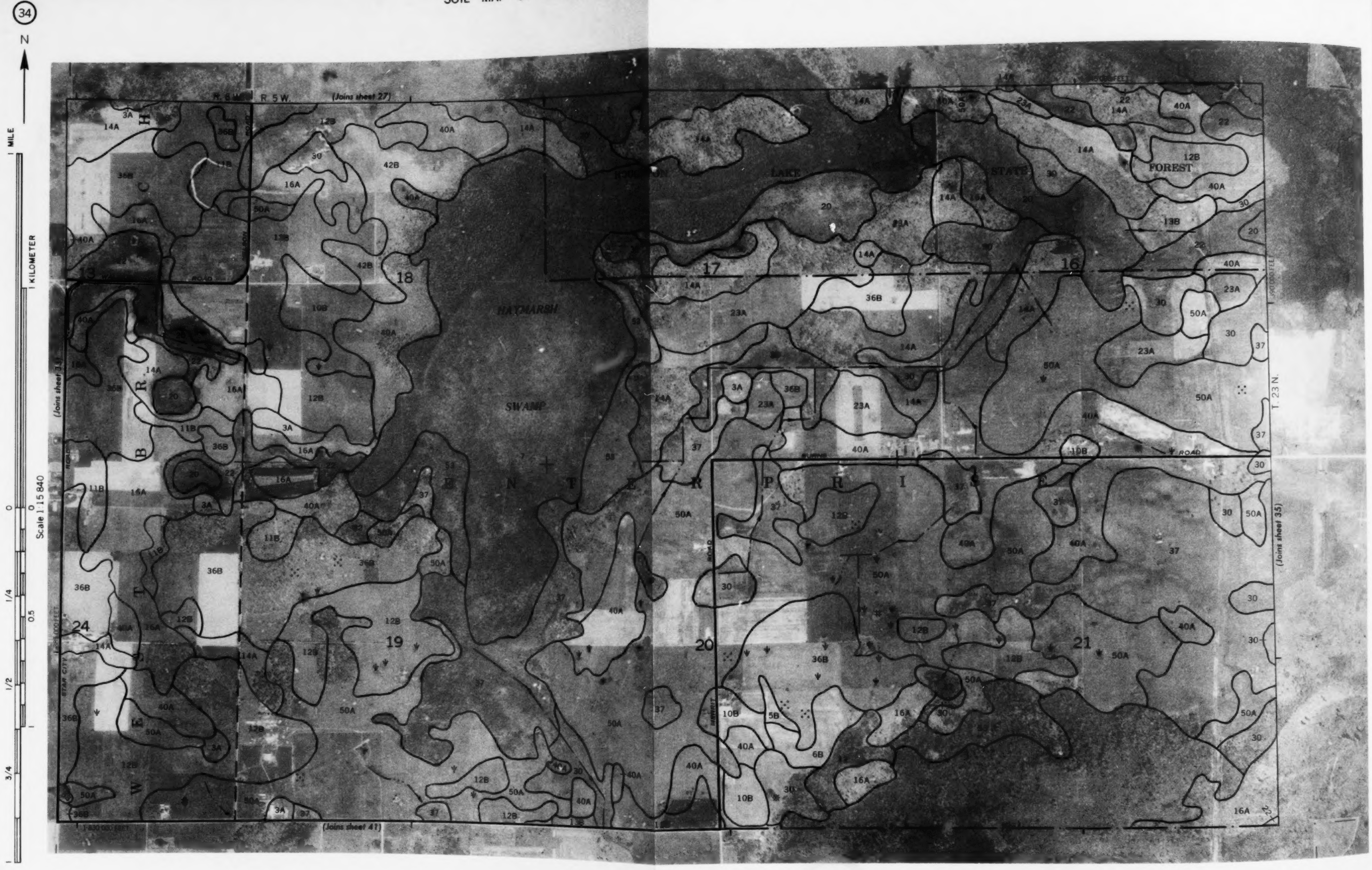
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 32


N
1 MILE
KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 25)
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 39)
R. 7 W.
R. 6 W.
T. 23 N.
390 000 FEET
HOUGHTON
LAKE
STATE
FOREST
W E S T B R A N C H
West Branch
Muskegon
River
WALKER ROAD
ROAD
13
14
17
18
19
20
23
24
3A
7
11B
11C
13B
13C
13E
14A
16A
20
22
40A
42B
42C

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 33

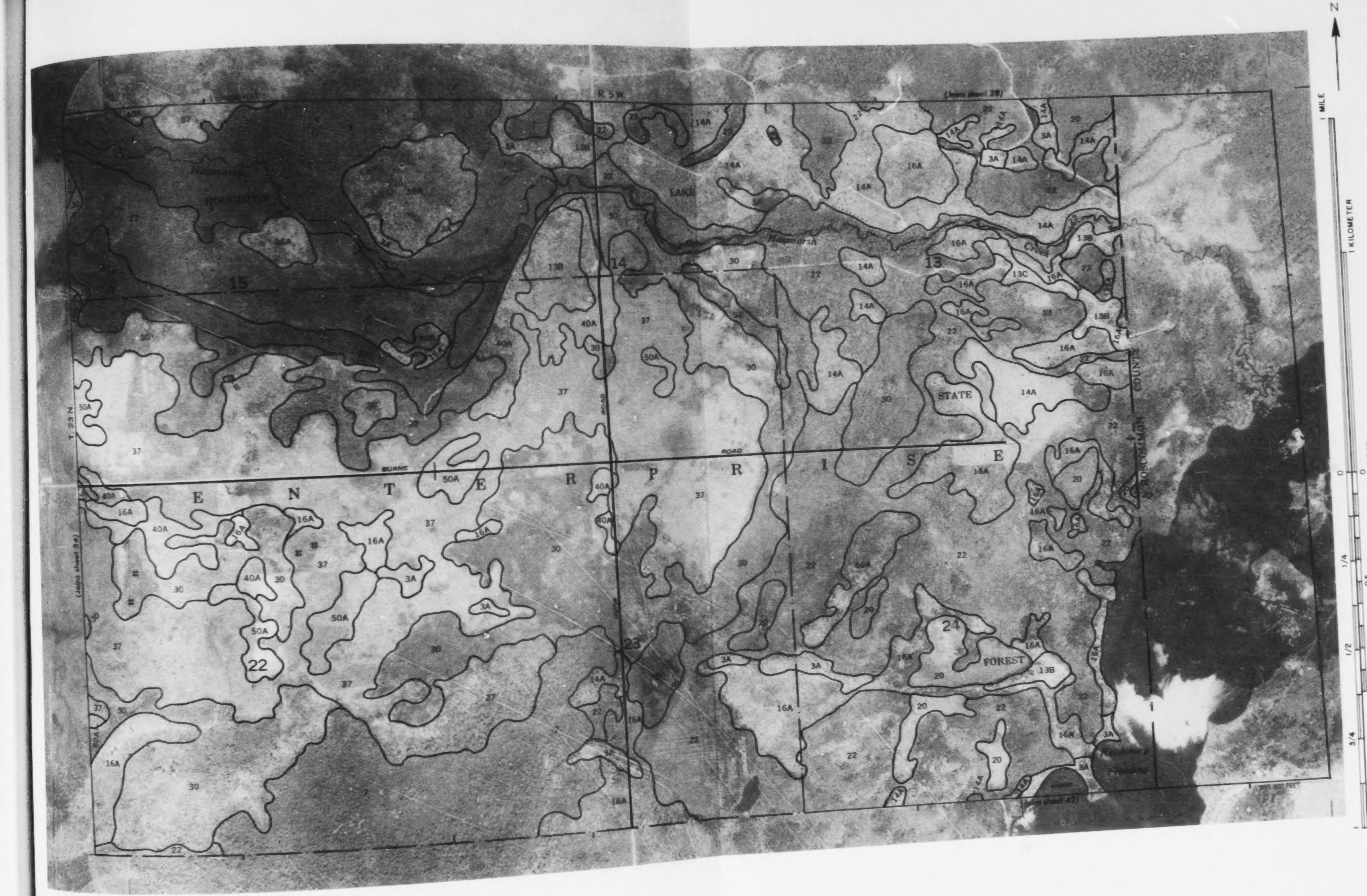

N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 26)
(Joins sheet 32)
(Joins sheet 34)
(Joins sheet 40)
R 6 W
T 21 N
HOUGHTON
LAKE
WALKER
ROAD
STEVENS
WEST
BRANCH
STATE
FOREST
Muskegon
River
West
Branch
13
14
15
16
21
22
23
24
3A
10B
11B
11C
12B
13B
13C
14A
16A
20
22
23A
30
36B
37
40A
42B
50A
53

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 34



(34)
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:15 840
R. 6 W.
R. 5 W.
(Joins sheet 27)
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 41)
T. 23 N.
LAKE
STATE
FOREST
HAYMARSH
SWAMP
ROAD
STAR CITY
13
17
16
18
24
19
20
21

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 35


N
(Joins sheet 28)
R. 5 W.
T. 23 N.
(Joins sheet 34)
(Joins sheet 42)
HOUGHTON
LAKE
Creek
BURNS
ROAD
ROAD
ENTERPRISE
STATE
FOREST
ROSCOMMON COUNTY
Water
15
14
13
22
23
24
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0
0.5
1
Scale 1:15 840

③⑥

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 36

N

1 MILE

1 KILOMETER

Scale 1:15 840

0

1/4

1/2

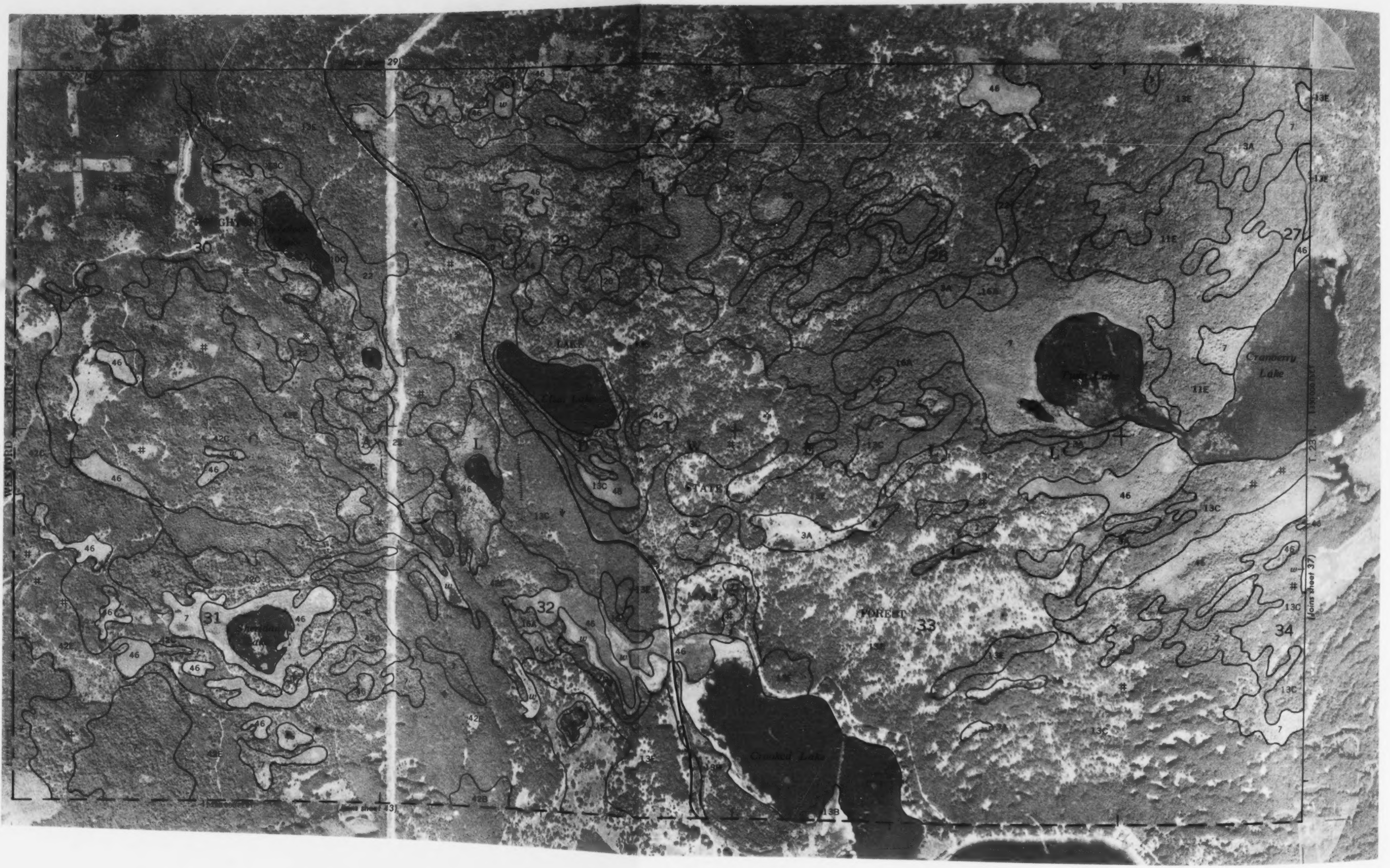
3/4

1

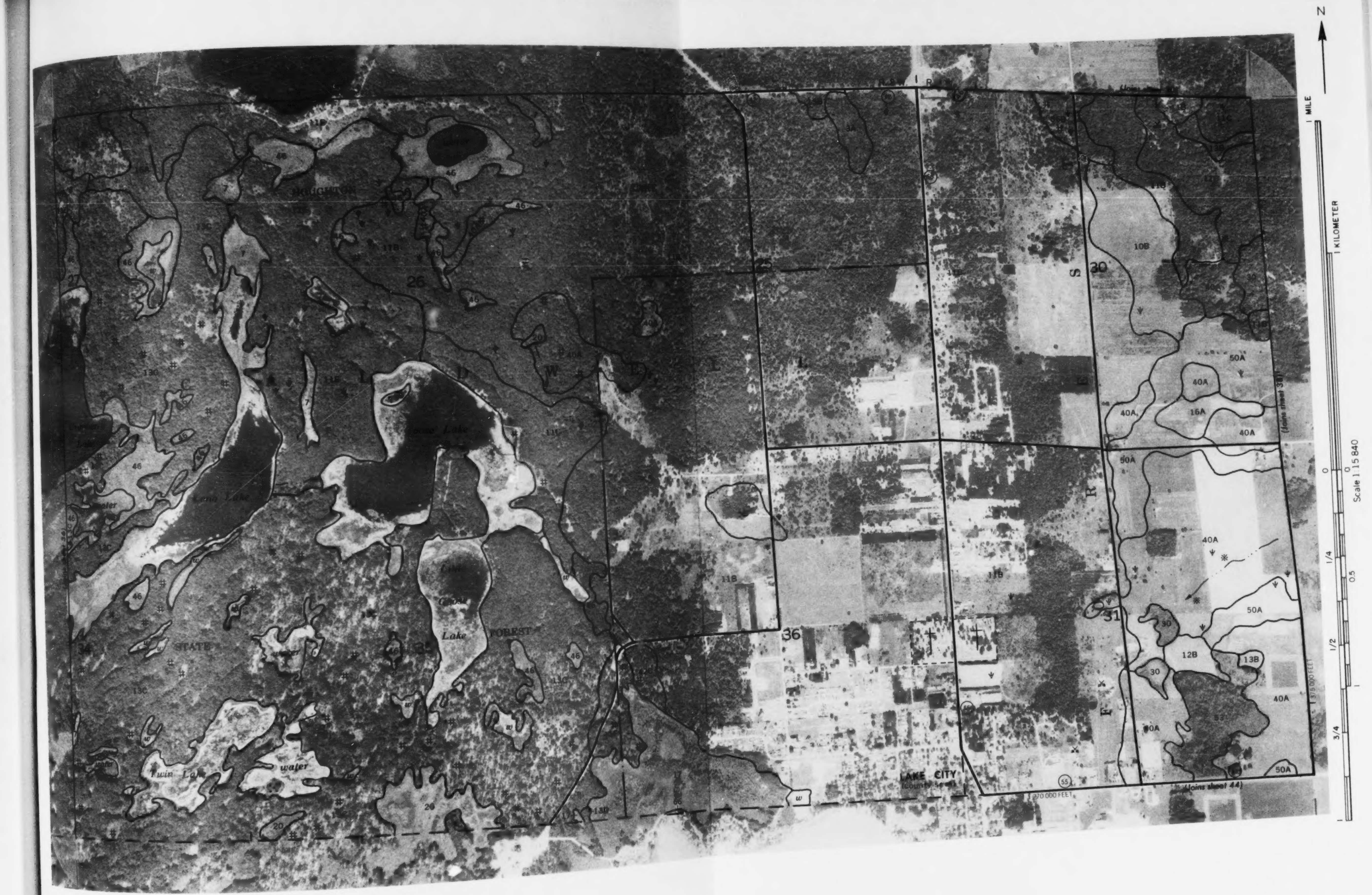
0

0.5

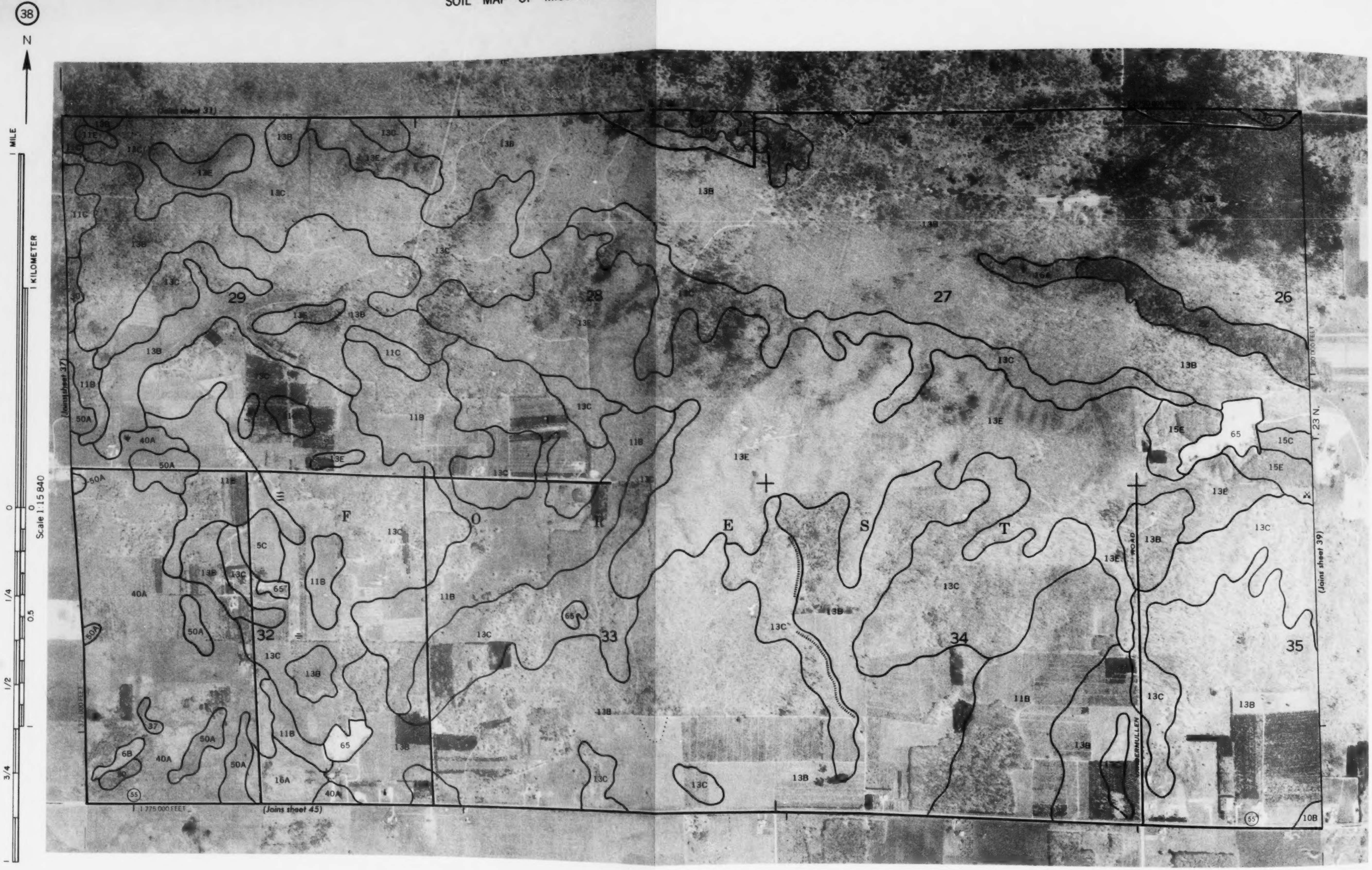
1


29
30
31
32
33
34
27
28
LAKE
Clam Lake
Twin Lake
Cranberry Lake
Crooked Lake
STATE
FOREST
WEXFORD
T. 23 N.
1 330 000 FEET
(Joins sheet 37)
(Joins sheet 43)
46
13C
13E
11E
42C
42B
3A
16A
7
22
w
#

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 37

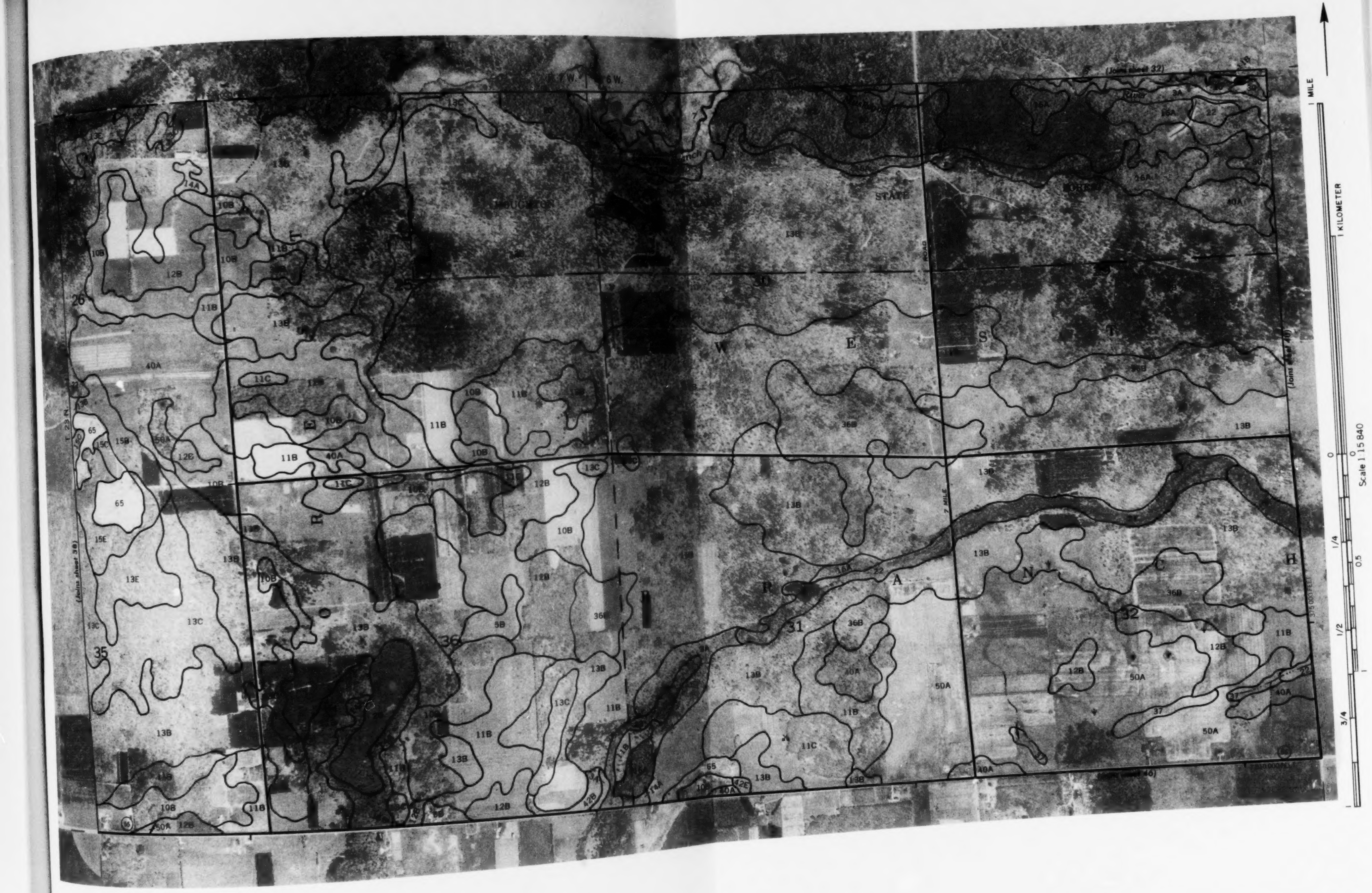

N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
R 8 W
R 7 W
(Joins sheet 30)
(Joins sheet 38)
(Joins sheet 44)
HOUGHTON
Long Lake
Goose Lake
Little Goose Lake
Twin Lake
water
STATE
FOREST
LAKE CITY
(County Seat)
26
25
30
35
36
31
27
34
S
L
D
W
R
E
10B
11B
12B
13B
13C
16A
20
30
33
40A
46
50A
7
55
2 270 000 FEET
375 000 FEET

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 38

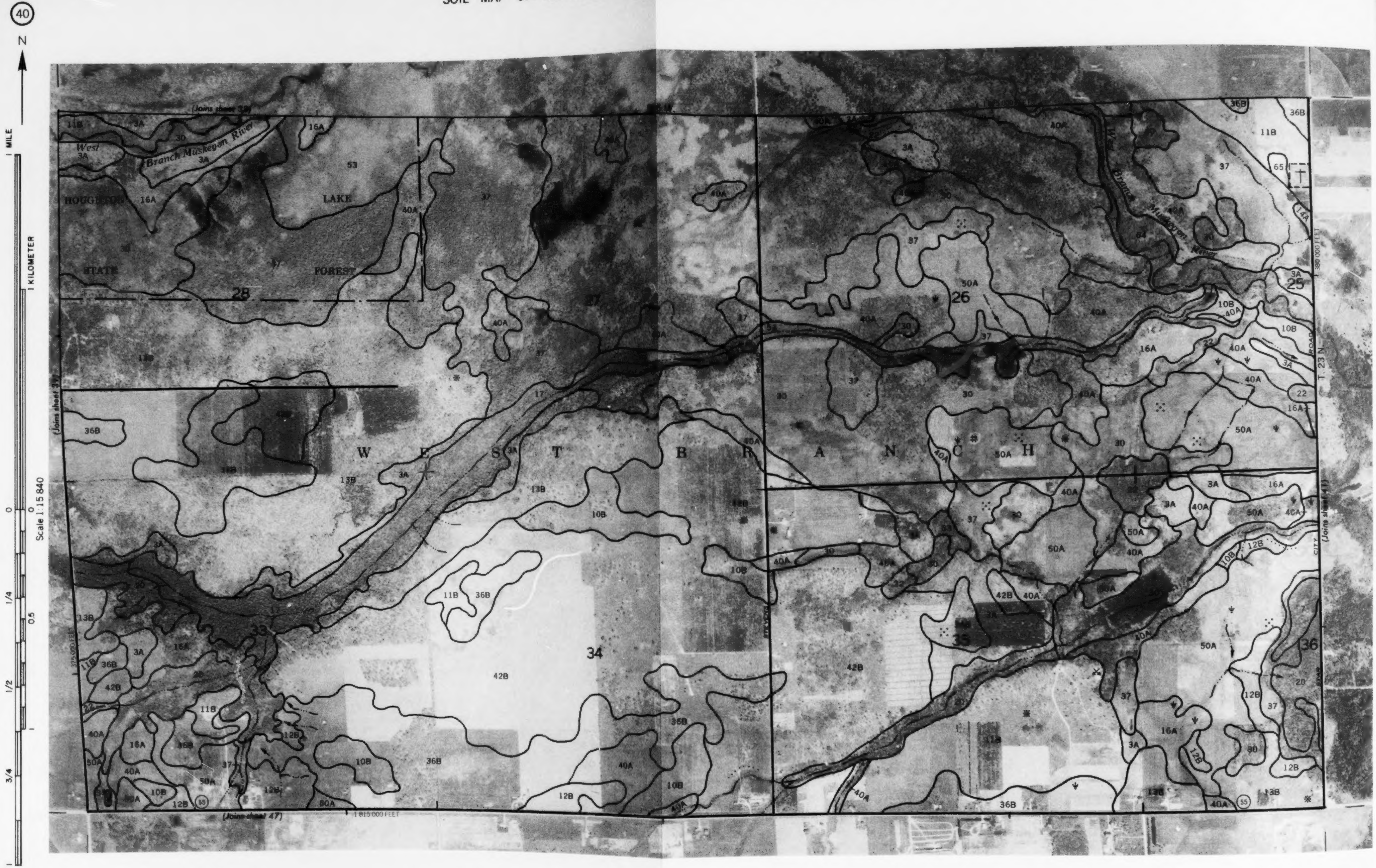


38
N
MILE
KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 31)
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 45)
T. 23 N.
29
28
27
26
32
33
34
35
F O R E S T
ROAD
VANDERMULLEN
55
13B
13C
13E
11B
11C
11E
15C
15E
16A
40A
50A
5C
6B
10B
37
65

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 39

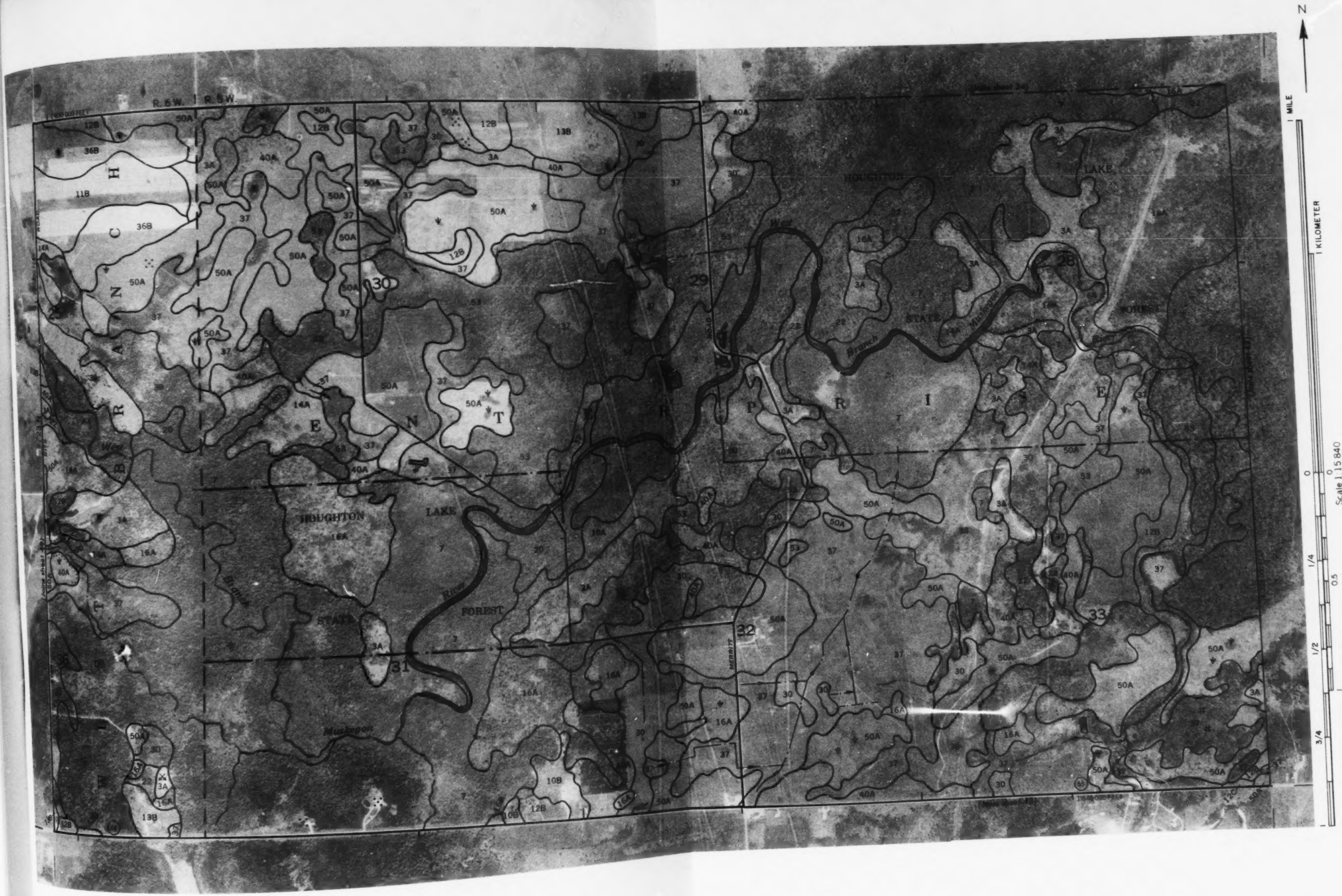

N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
(Joins sheet 32)
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 40)
R. 7 W.
R. 6 W.
T. 22 N.
HOUGHTON
STATE
FOREST
W
E
S
T
B
R
A
N
C
H
E
R
O
R
26
35
36
31
32
30
7 MILE
ROAD
13B
12B
10B
11B
14A
40A
11C
65
15B
15C
15E
13E
13C
36B
16A
22
50A
37
12E
5B
42B
55
3A
20
42E

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 40

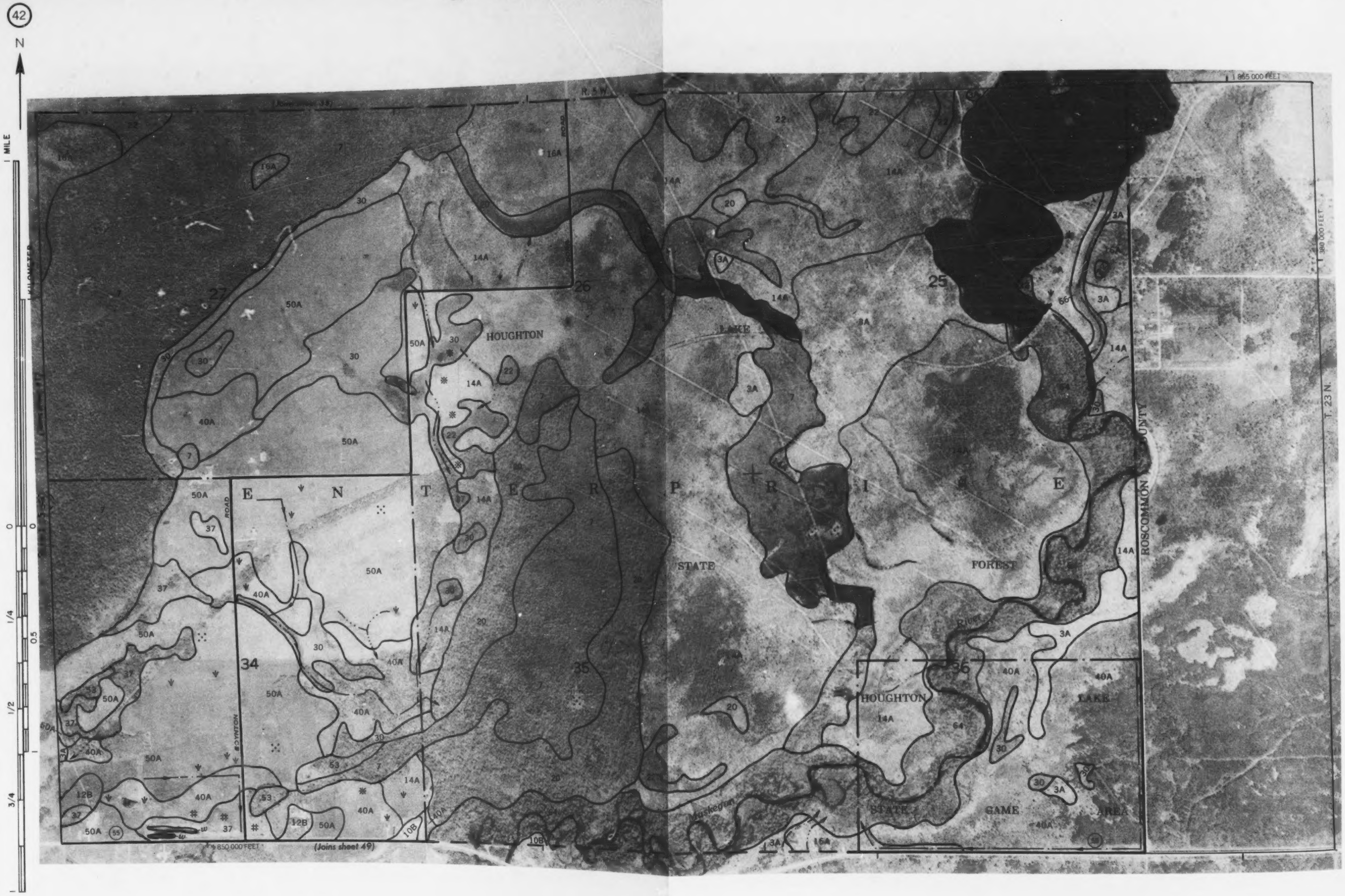


40
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 39)
(Joins sheet 37)
(Joins sheet 47)
(Joins sheet 41)
West Branch Muskegon River
West Branch Muskegon River
HOUGHTON LAKE STATE FOREST
WEST BRANCH
28
27
26
25
33
34
35
36
T. 23 N.
1 815 000 FEET
385 000 FEET
375 000 FEET
3A
11B
16A
30
53
37
40A
13B
36B
17
55
10B
12B
20
22
42B
50A
65
14A

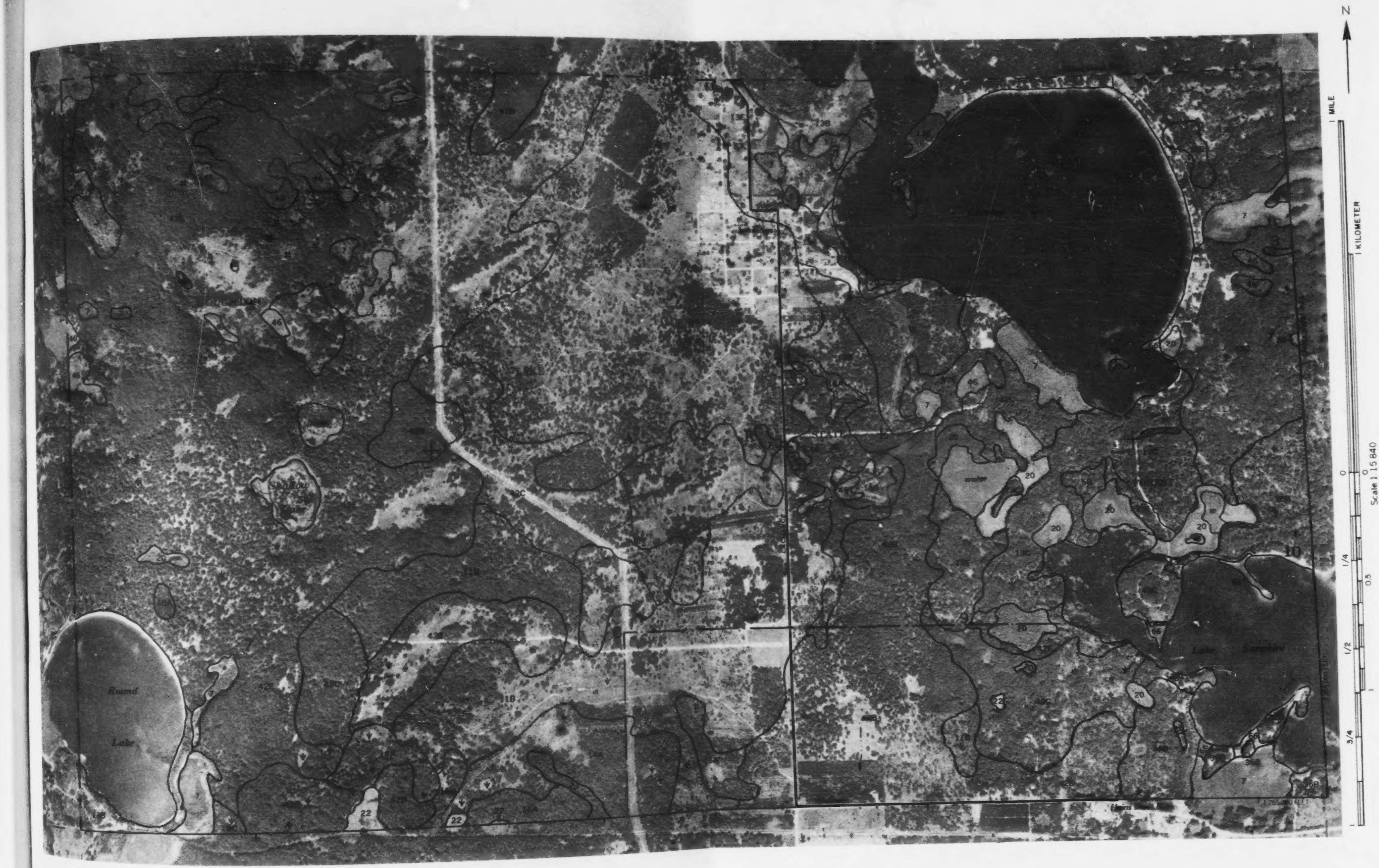
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 41


N
R. 6 W.
R. 5 W.
HOUGHTON LAKE STATE FOREST
West Branch Muskegon River
MERRITT ROAD
28
29
30
31
32
33
3A
7
10B
11B
12B
13B
14A
16A
20
22
30
36B
37
40A
50A
53
MILE
0
1/4
1/2
3/4
1
KILOMETER
0
0.5
1
Scale 1:15 840

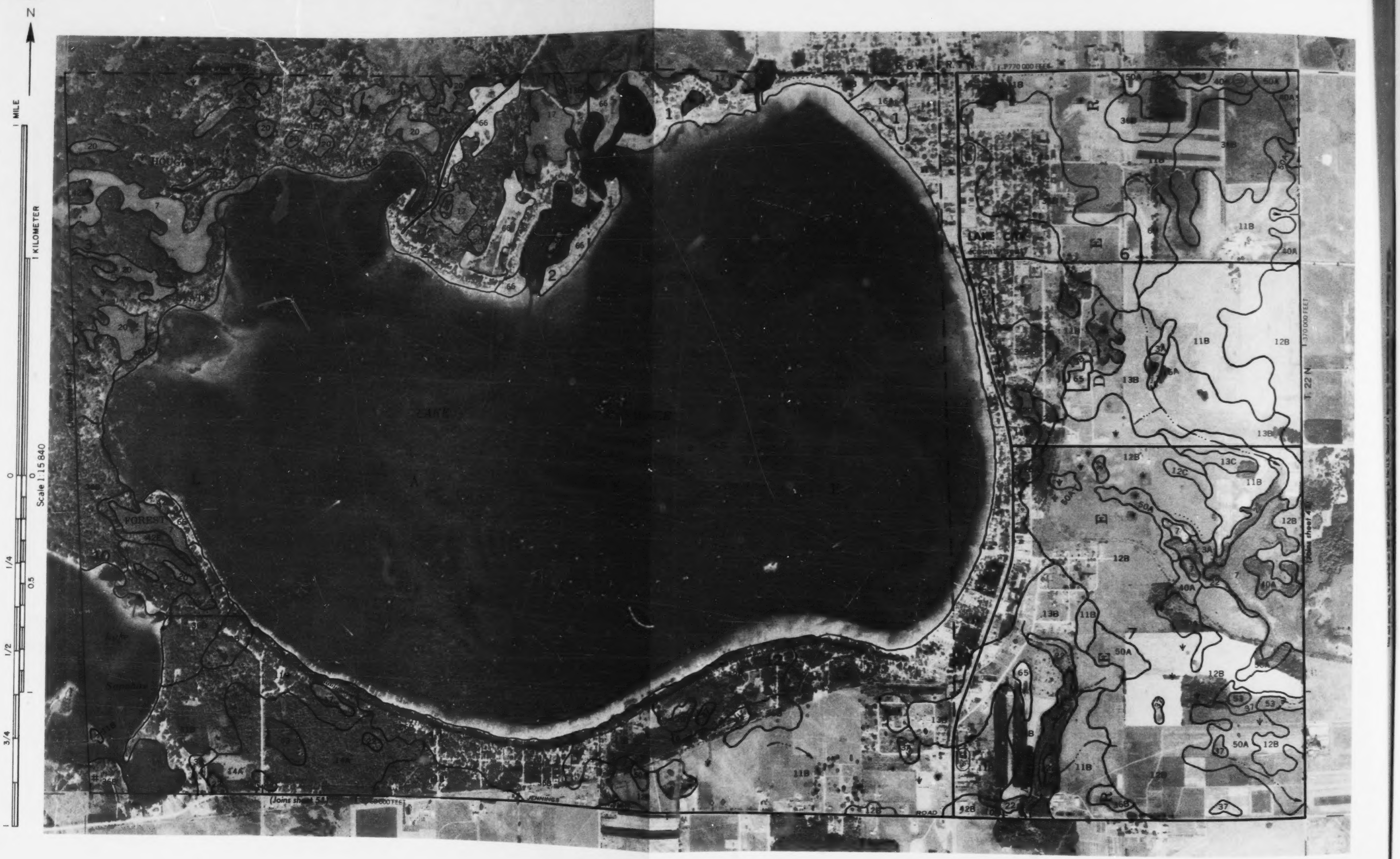
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 42


42
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
R. 5 W.
T. 23 N.
1 865 000 FEET
380 000 FEET
1 850 000 FEET
(Joins sheet 49)
ROSCOMMON COUNTY
HOUGHTON LAKE
E N T E R P R I S E
STATE FOREST
STATE GAME AREA
ROAD
BOYNTON ROAD
Muskegon River
27
26
25
34
35
36
3A
7
10B
12B
14A
16A
20
22
30
37
40A
50A
53
55
64

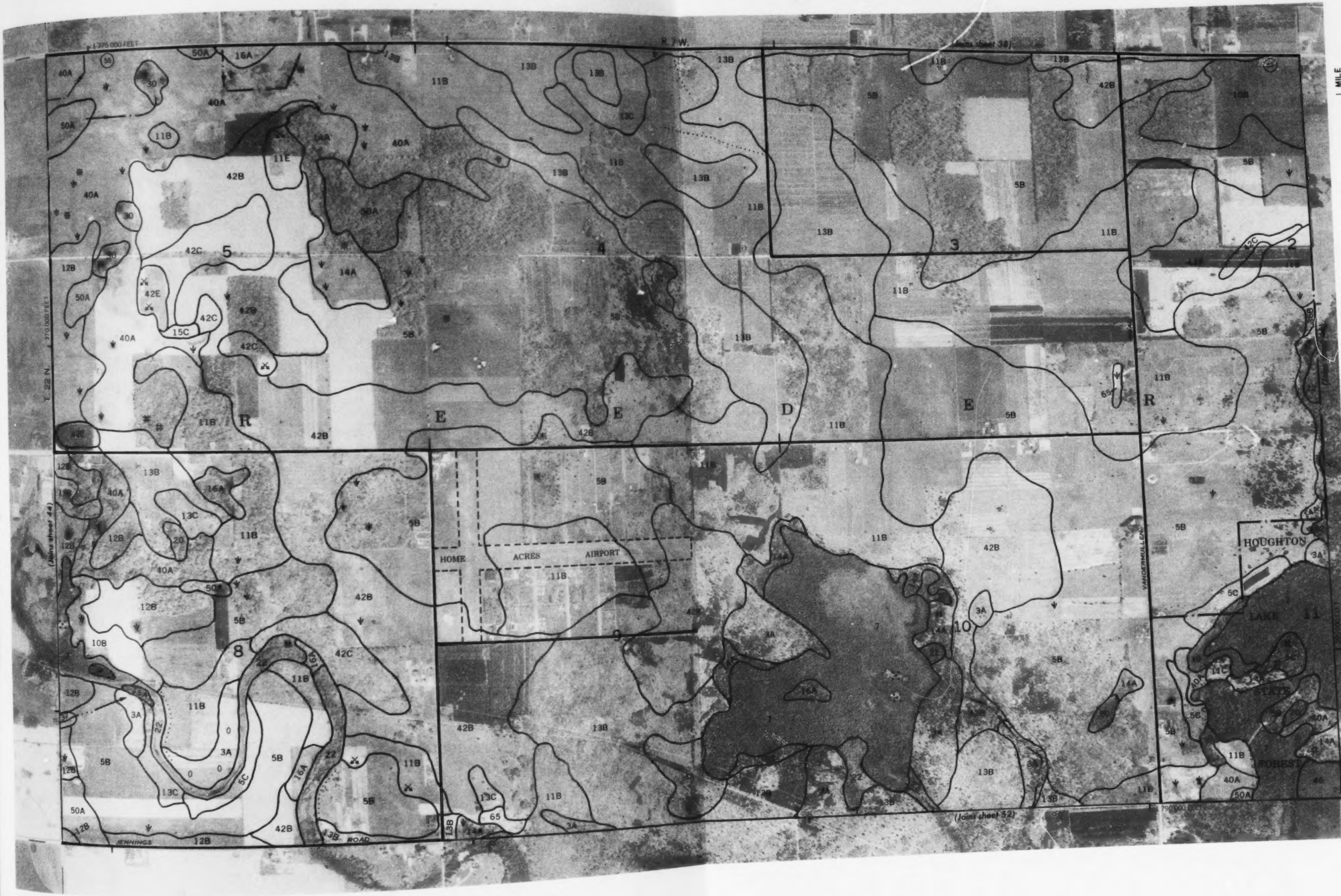
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 43


N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
Round
Lake
Lake
Sapphire
7
20
22
11B
13C
13B
42B
42C
46
56
26
10

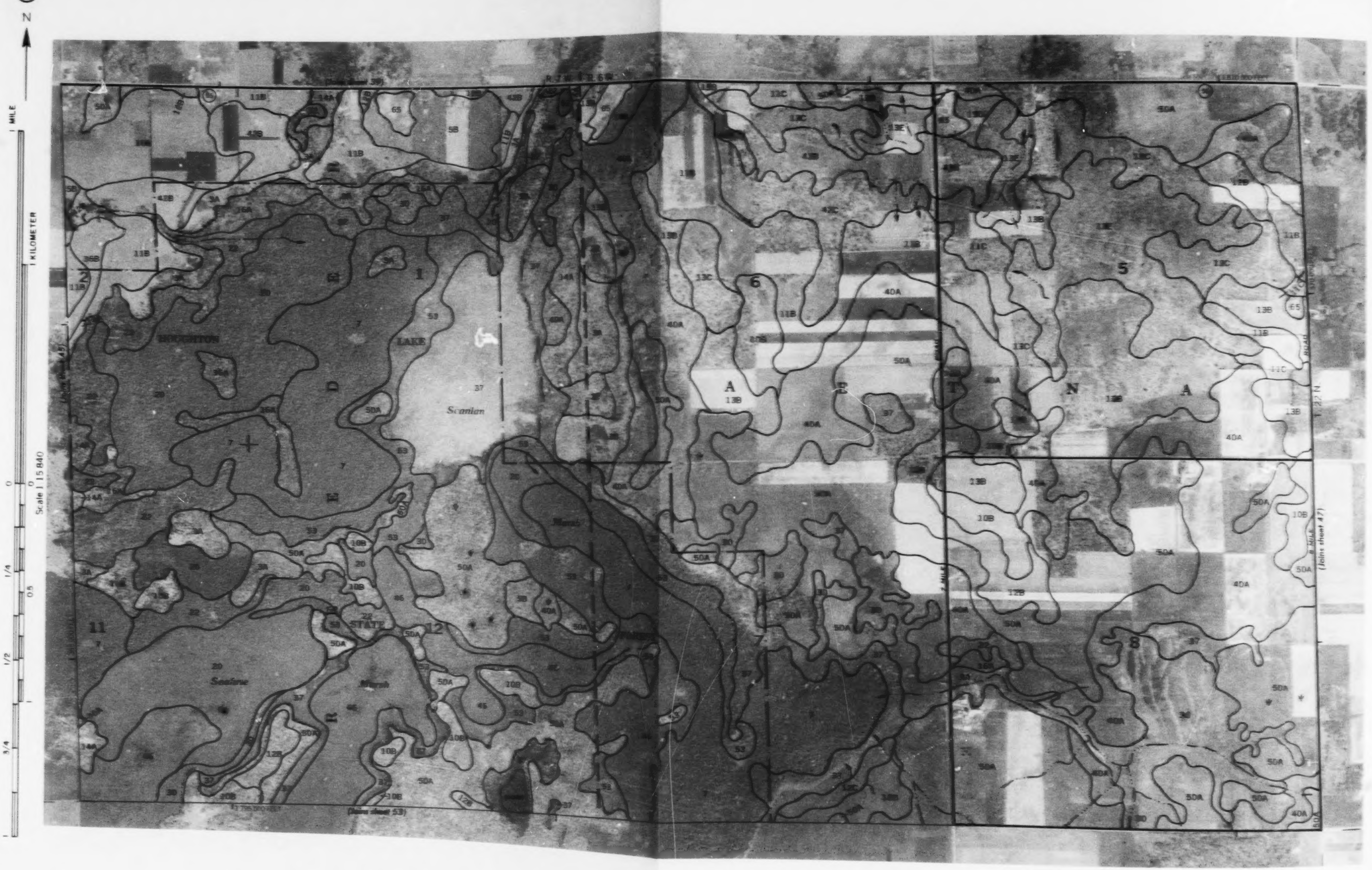
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 44


N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
1
Scale 1:15 840
LAKE CITY
LAKE
R
6
7
T. 22 N
FOREST
(Joins sheet 55)
(Joins sheet 45)
JENNINGS
ROAD
1 770 000 FEET
370 000 FEET
1
2
11B
12B
13B
12C
13C
34B
36B
40A
50A
3A
7
16A
17
20
22
37
53
65
66

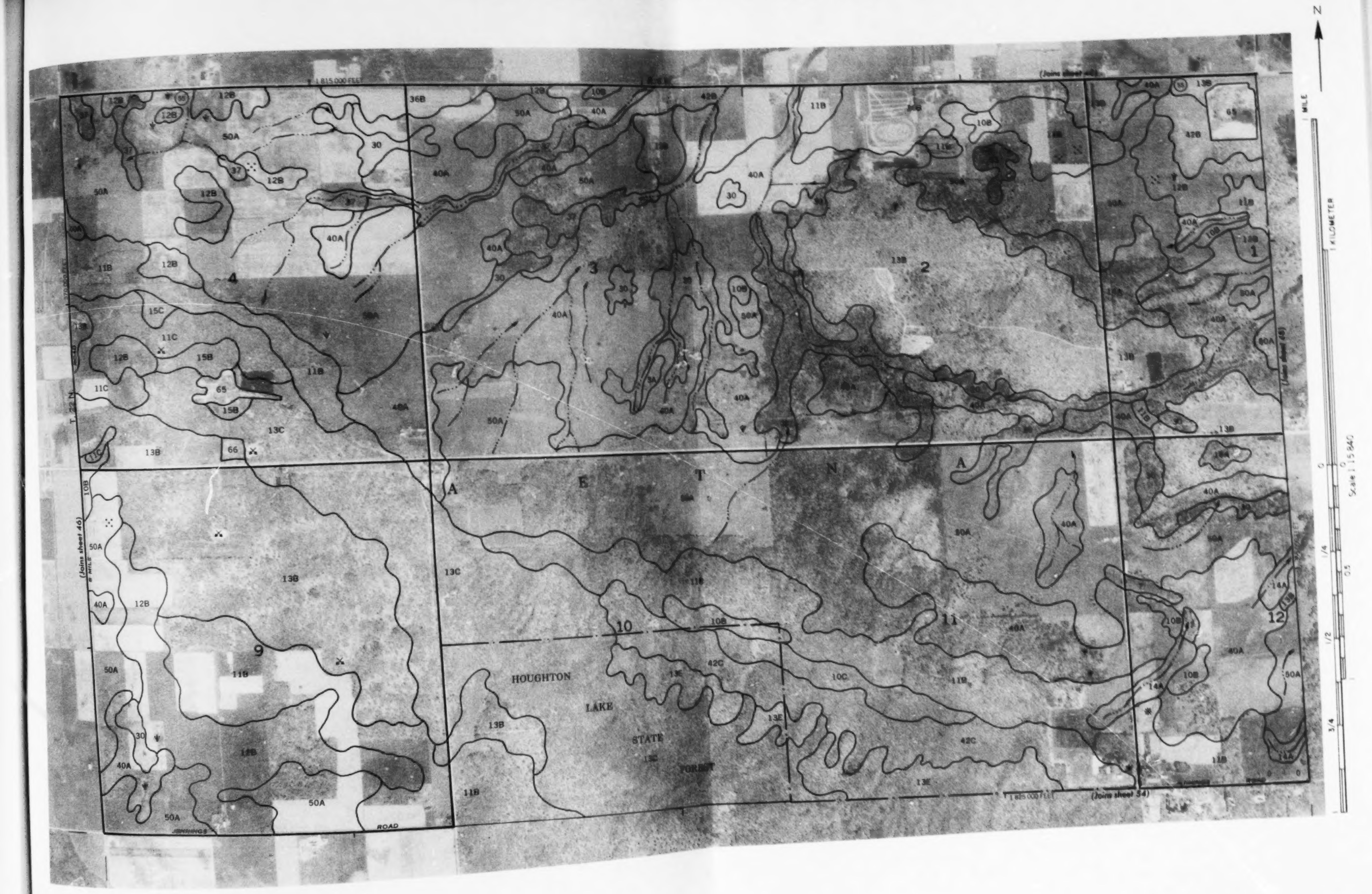
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 45


1 375 000 FEET
R. 7 W.
(Joins sheet 38)
T. 22 N.
370 000 FEET
(Joins sheet 44)
(Joins sheet 52)
790 000 FEET
1 MILE
5
4
3
2
8
9
10
11
R
E
E
D
E
R
HOME
ACRES
AIRPORT
HOUGHTON
LAKE
STATE
FOREST
VANDERMULLEN
JENNINGS
ROAD
40A
50A
16A
13B
11B
42B
42C
42E
5B
5C
14A
58A
12B
15C
13C
10B
3A
22
0
7
65
42B
11E
20
30
46

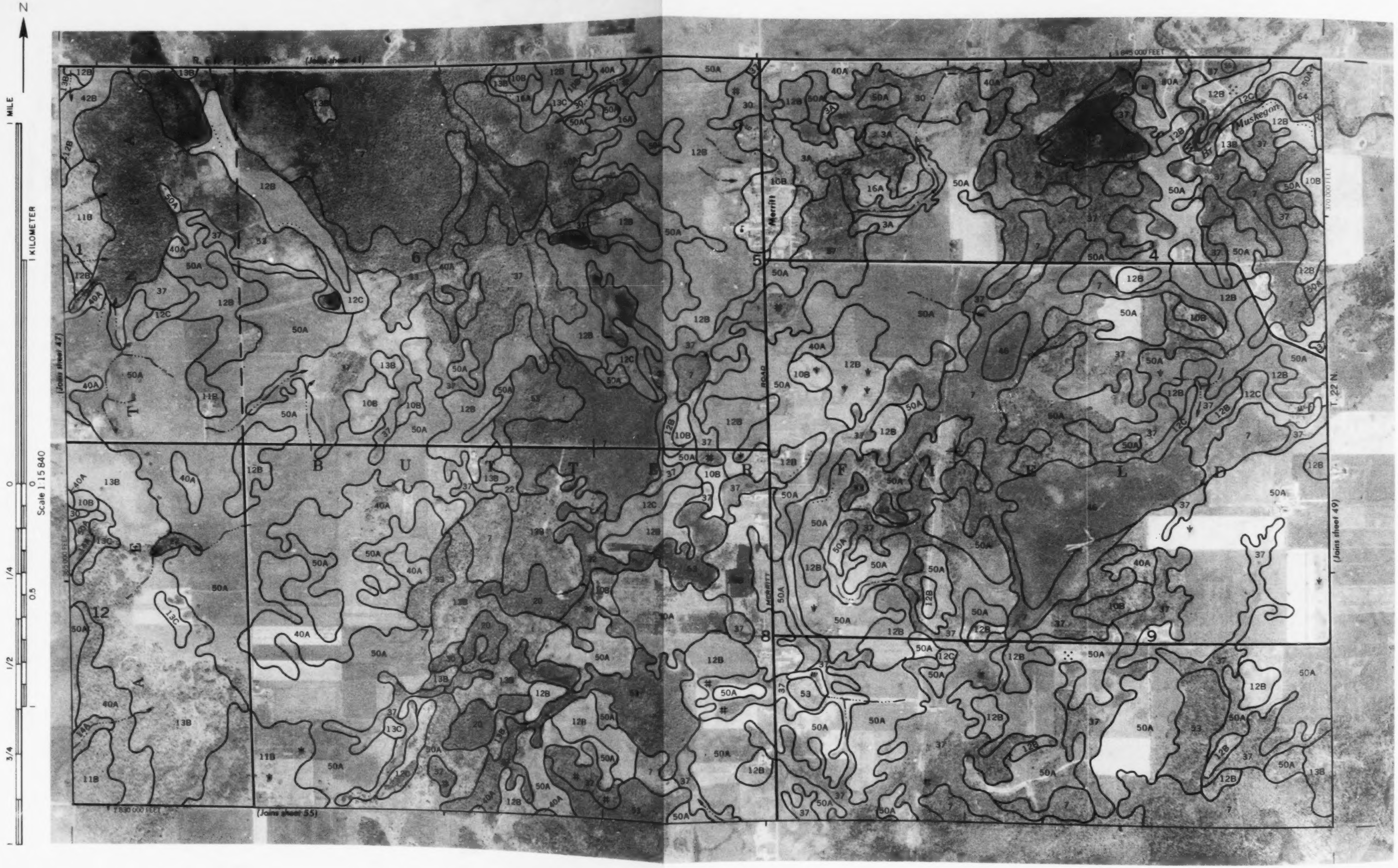
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 46


N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 39)
(Joins sheet 47)
(Joins sheet 53)
R. 7 W. | R. 6 W.
T. 22 N.
HOUGHTON
LAKE
Scanlan
Marsh
STATE
Seeley
2
1
6
5
11
12
7
8
50A
11B
13B
13C
40A
37
20
7
53
10B
12B

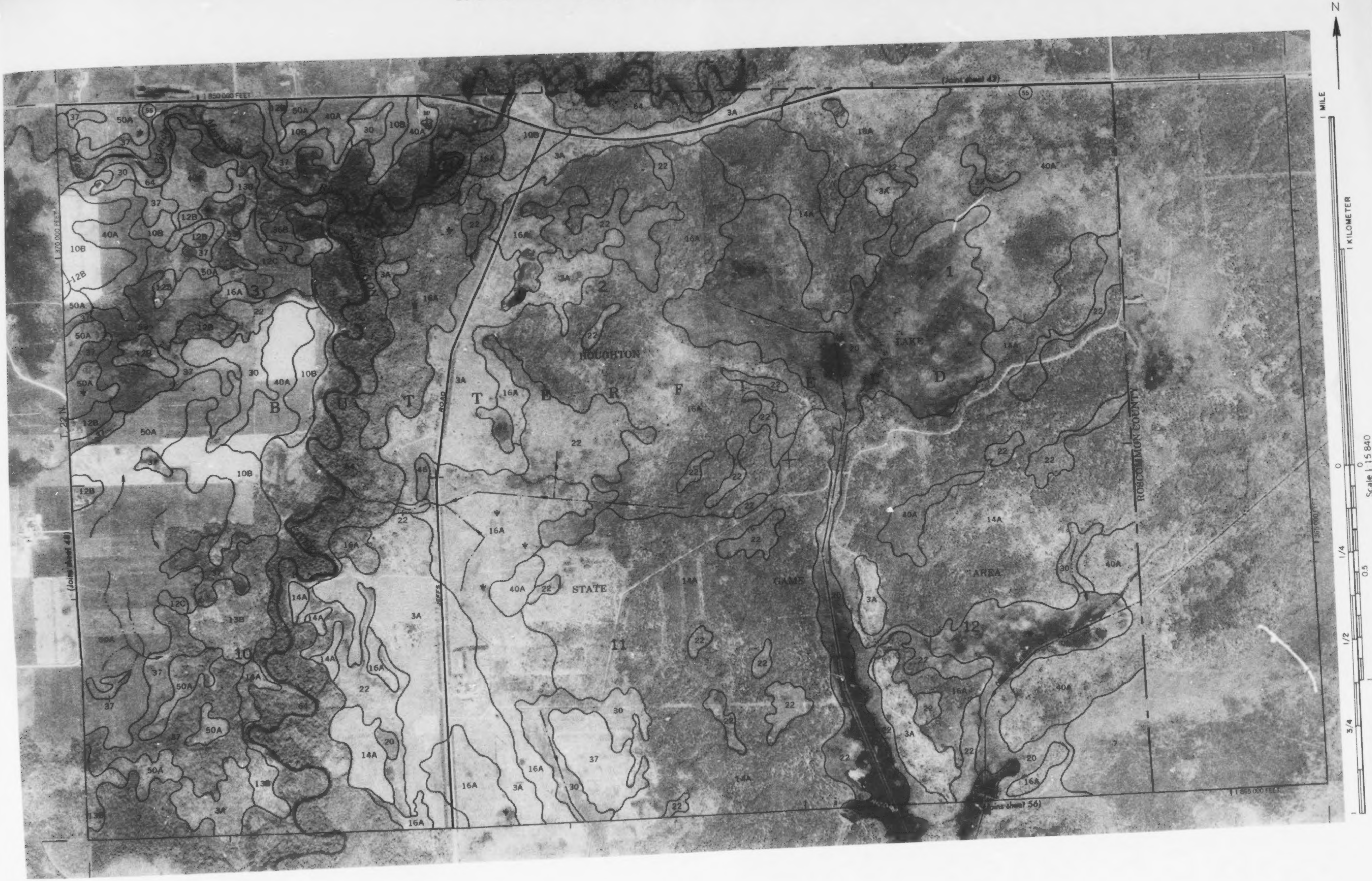
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 47


N
(Joins sheet 40)
1 815 000 FEET
(Joins sheet 46)
(Joins sheet 48)
(Joins sheet 54)
T. 22 N.
4
3
2
1
9
10
11
12
A E T N A
HOUGHTON LAKE STATE FOREST
JENNINGS ROAD
MILE
KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0.5
10B
11B
11C
12B
13B
13C
13E
14A
15B
15C
30
36B
37
40A
42B
42C
50A
55
65
66

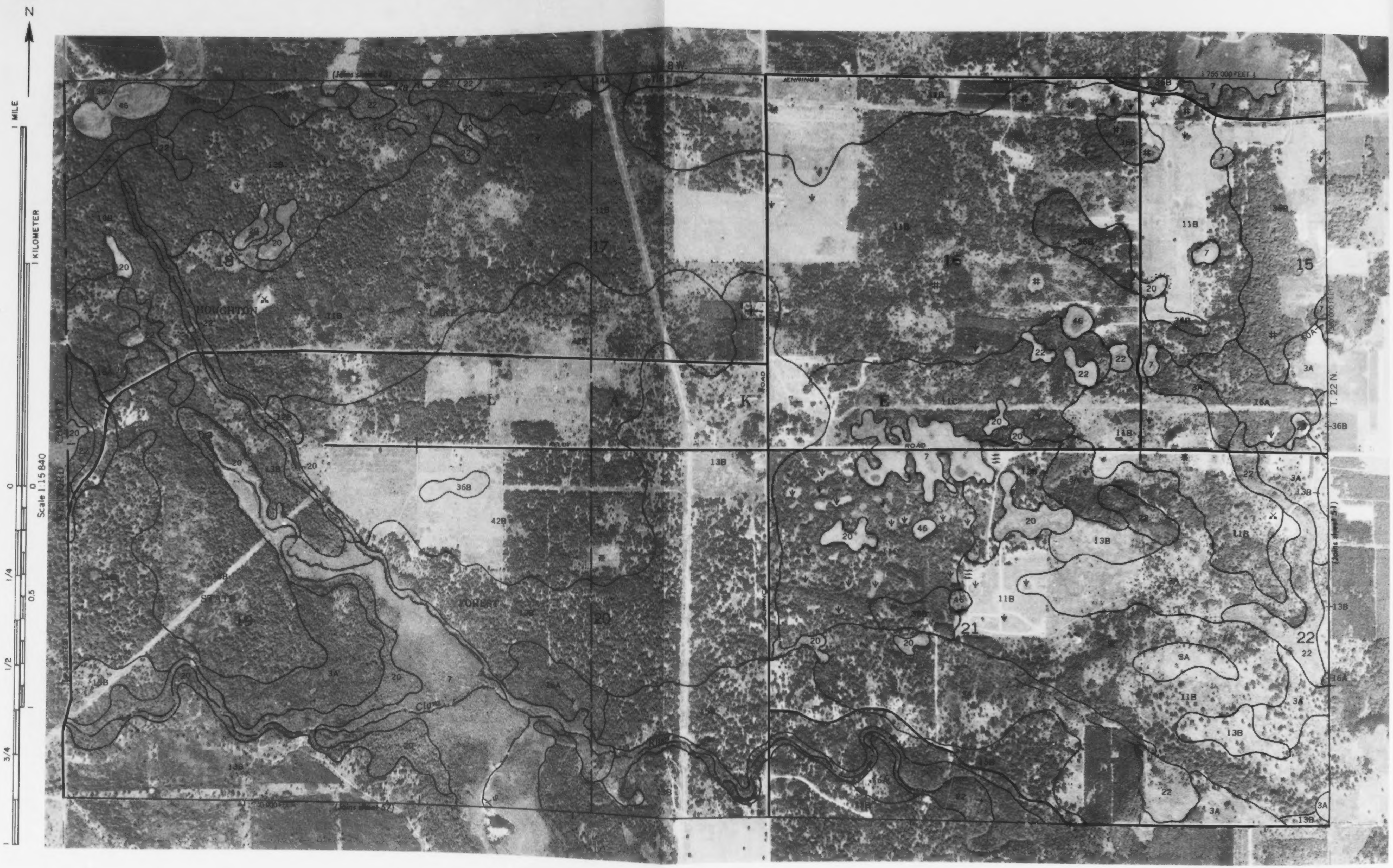
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 48


N
MILE
KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
R. 6 W. | R. 5 W.
(Joins sheet 41)
(Joins sheet 47)
(Joins sheet 49)
(Joins sheet 55)
T. 22 N.
1 845 000 FEET
1 830 000 FEET
370 000 FEET
Merritt
MERRITT
ROAD
Muskegon
B U T T E R F I E L D
1
6
5
4
12
7
8
9
12B
13B
42B
11B
40A
50A
37
12C
53
7
10B
3A
16A
30
64
13C
20
22
33

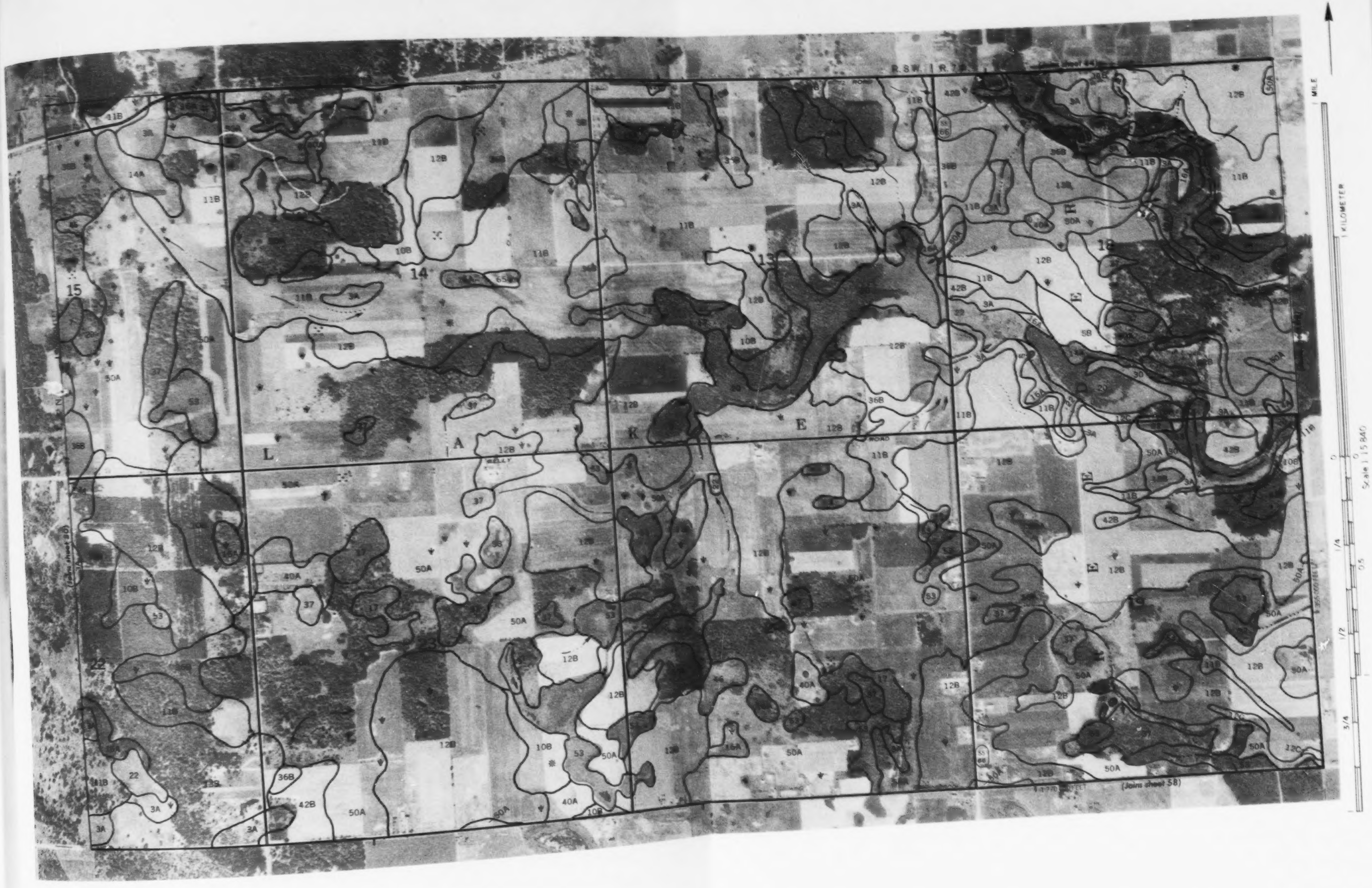
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 49


N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:15 840
(Joins sheet 43)
(Joins sheet 48)
(Joins sheet 56)
1 850 000 FEET
370 000 FEET
1 865 000 FEET
355 000 FEET
T 22 N
55
HOUGHTON LAKE STATE GAME AREA
BUTTERFIELD
ROSCOMMON COUNTY
1
2
3
10
11
12
50A
37
40A
30
10B
12B
13B
12C
16A
3A
14A
22
20
64
36B
46

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 50

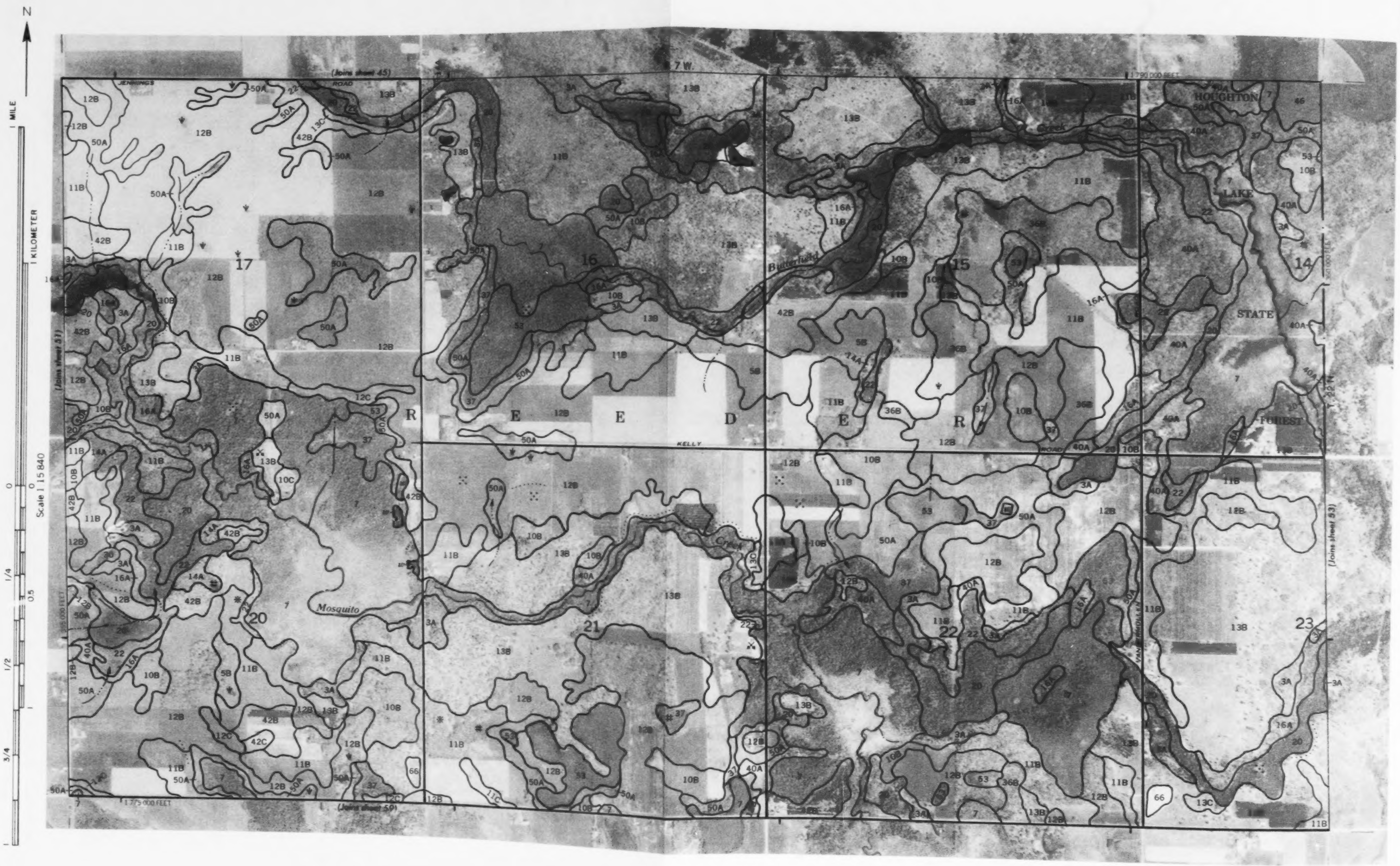

N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 43)
8 W.
JENNINGS
1 765 000 FEET
HOUGHTON
LAKE
STATE
FOREST
ROAD
ROAD
WEXFORD COUNTY
Clam
T. 22 N.
(Joins sheet 51)
(Joins sheet 57)
18
17
16
15
19
20
21
22
L
A
K
E
3A
7
11B
11C
13B
14A
16A
20
22
36B
36A
42B
46

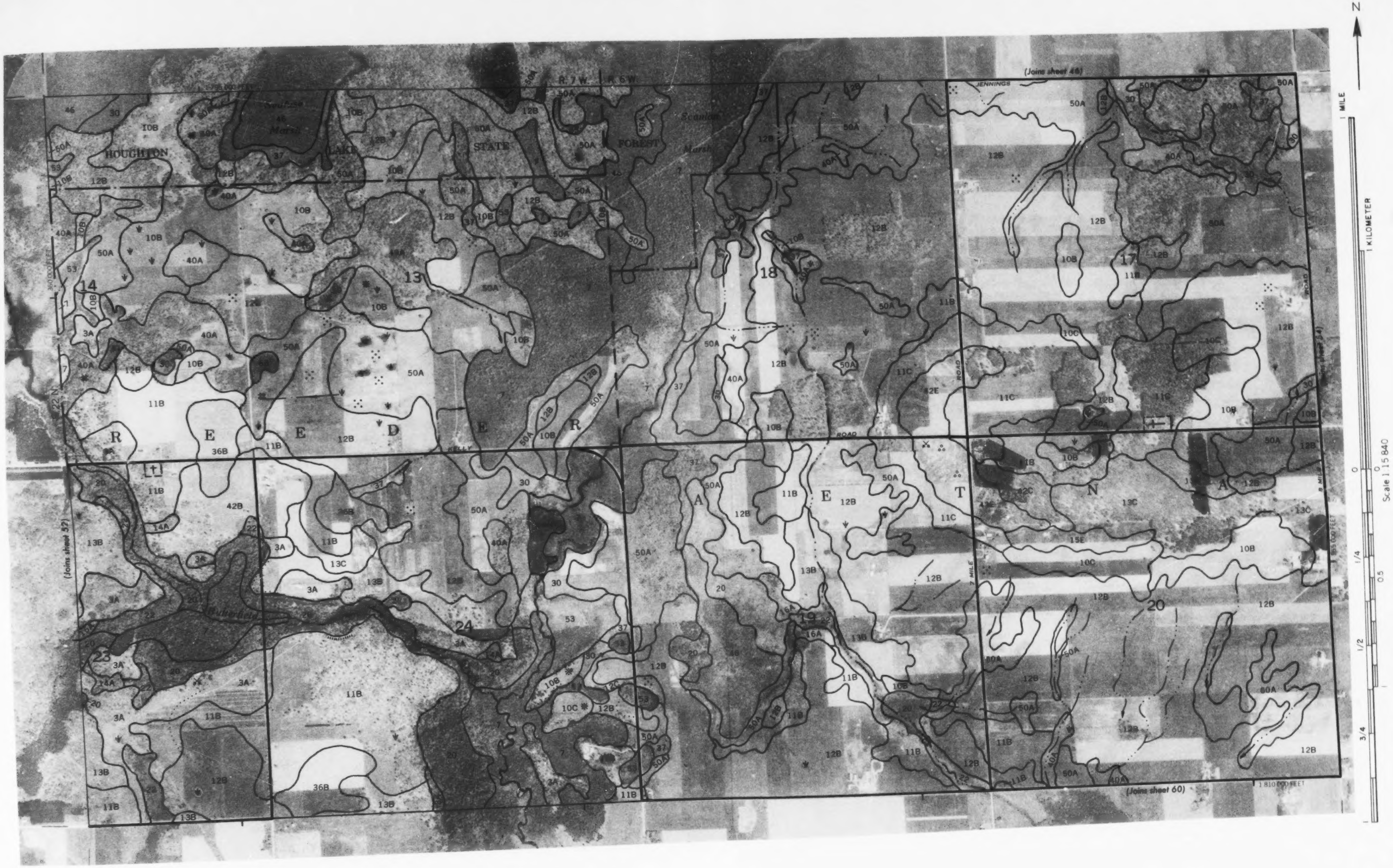
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 51


N
R.8 W.
R.7 W.
15
14
13
18
22
L
A
K
E
E
R
E
E
(Joins sheet 50)
(Joins sheet 58)
MILE
KILOMETER
0
1/4
1/2
3/4
0
0.5
Scale 1:15 840

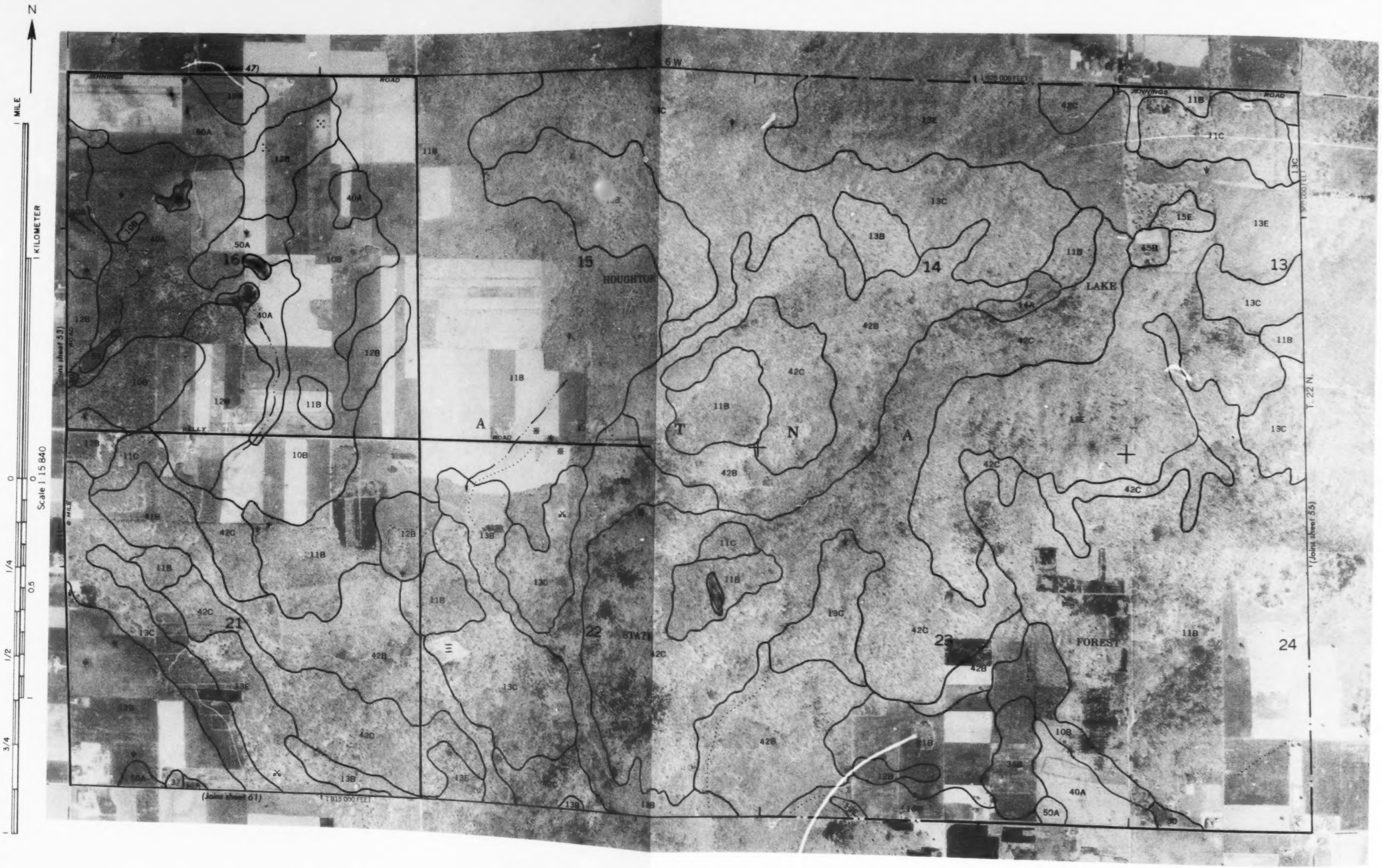
52

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 52

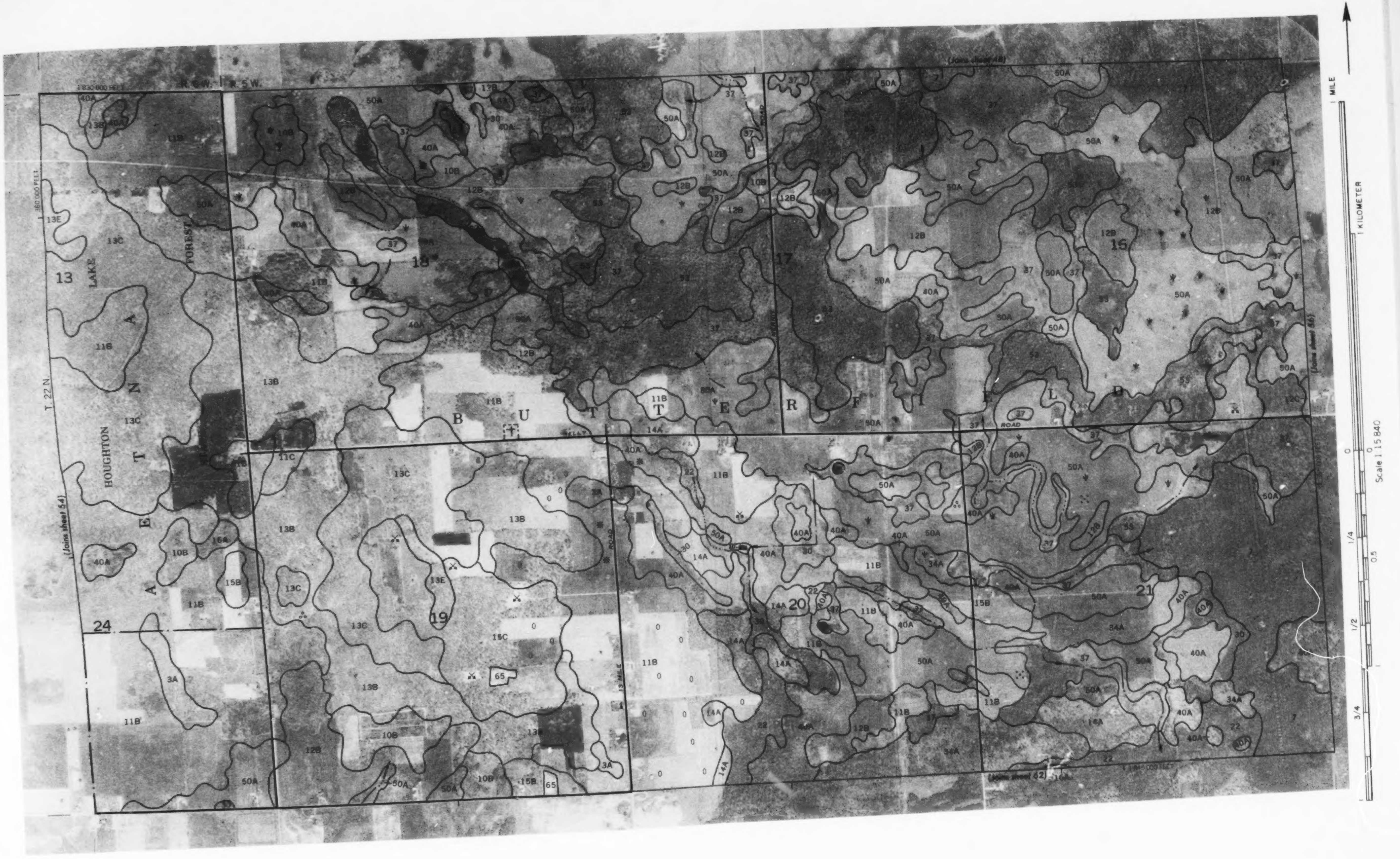

N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0.5
(Joins sheet 45)
JENNINGS
ROAD
7 W.
1 790 000 FEET
HOUGHTON
LAKE
STATE
FOREST
Butterfield
Creek
Mosquito
Creek
R
E
E
D
E
R
KELLY
ROAD
(Joins sheet 51)
(Joins sheet 53)
(Joins sheet 59)
1 775 000 FEET
T. 22 N.
17
16
15
14
20
21
22
23


N
(Joins sheet 46)
(Joins sheet 52)
(Joins sheet 54)
(Joins sheet 60)
R. 7 W.
R. 6 W.
T. 22 N.
HOUGHTON LAKE STATE FOREST
Scanlon Marsh
Marsh
R E E D E R
A E T N A
JENNINGS
KELLY
ROAD
7 MILE
8 MILE
13
14
17
18
19
20
23
24
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0.5
1 810 000 FEET

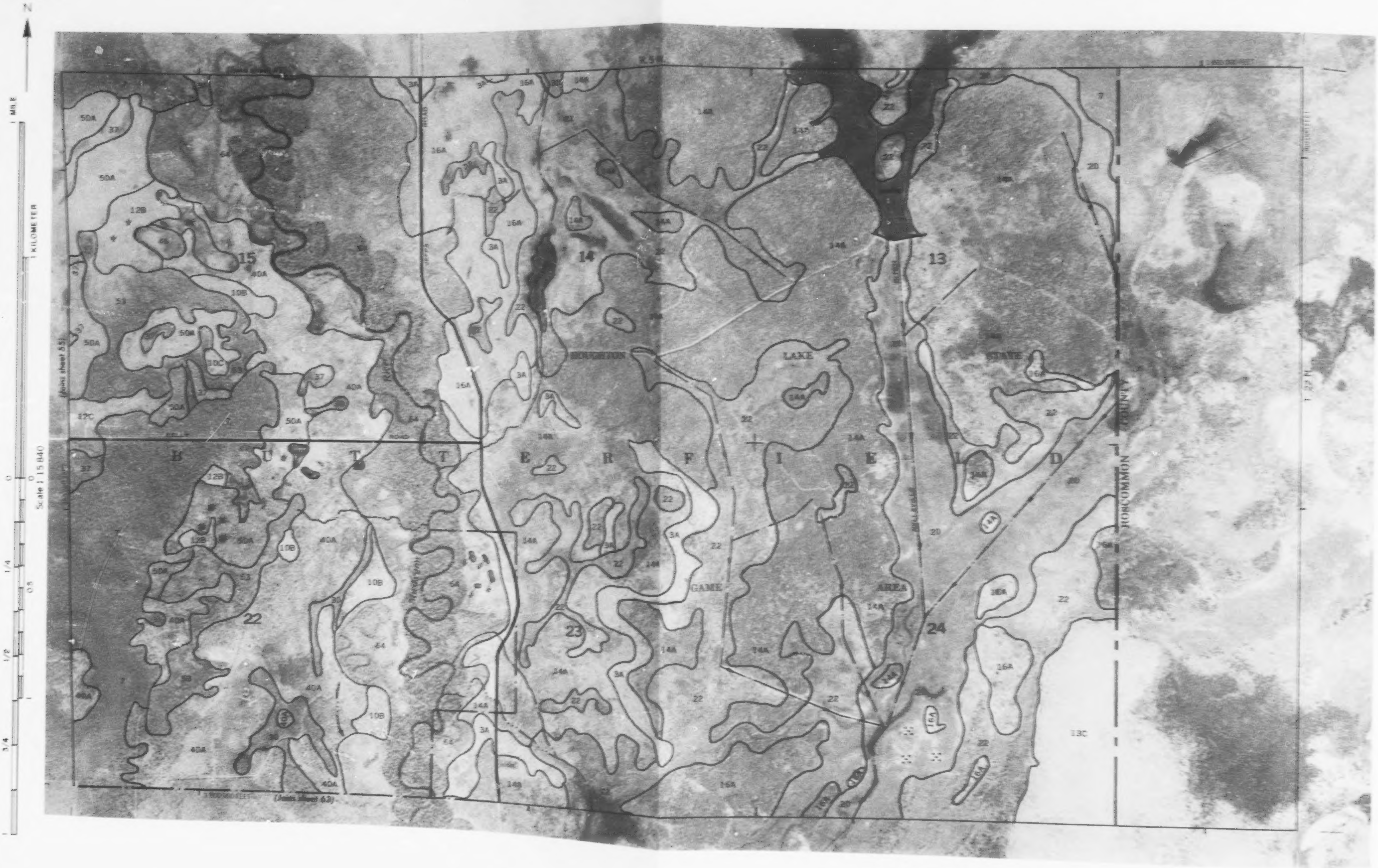
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 54


N
1 MILE
1 KILOMETER
0
0
1/4
0.5
1/2
1
3/4
Scale 1:15 840
(Joins sheet 47)
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 61)
JENNINGS
ROAD
6 W.
T. 22 N.
HOUGHTON
LAKE
STATE
FOREST
A
T
N
A
13
14
15
16
21
22
23
24
10B
11B
11C
12B
13B
13C
13E
14A
15E
35B
37
40A
42B
42C
50A
ROAD

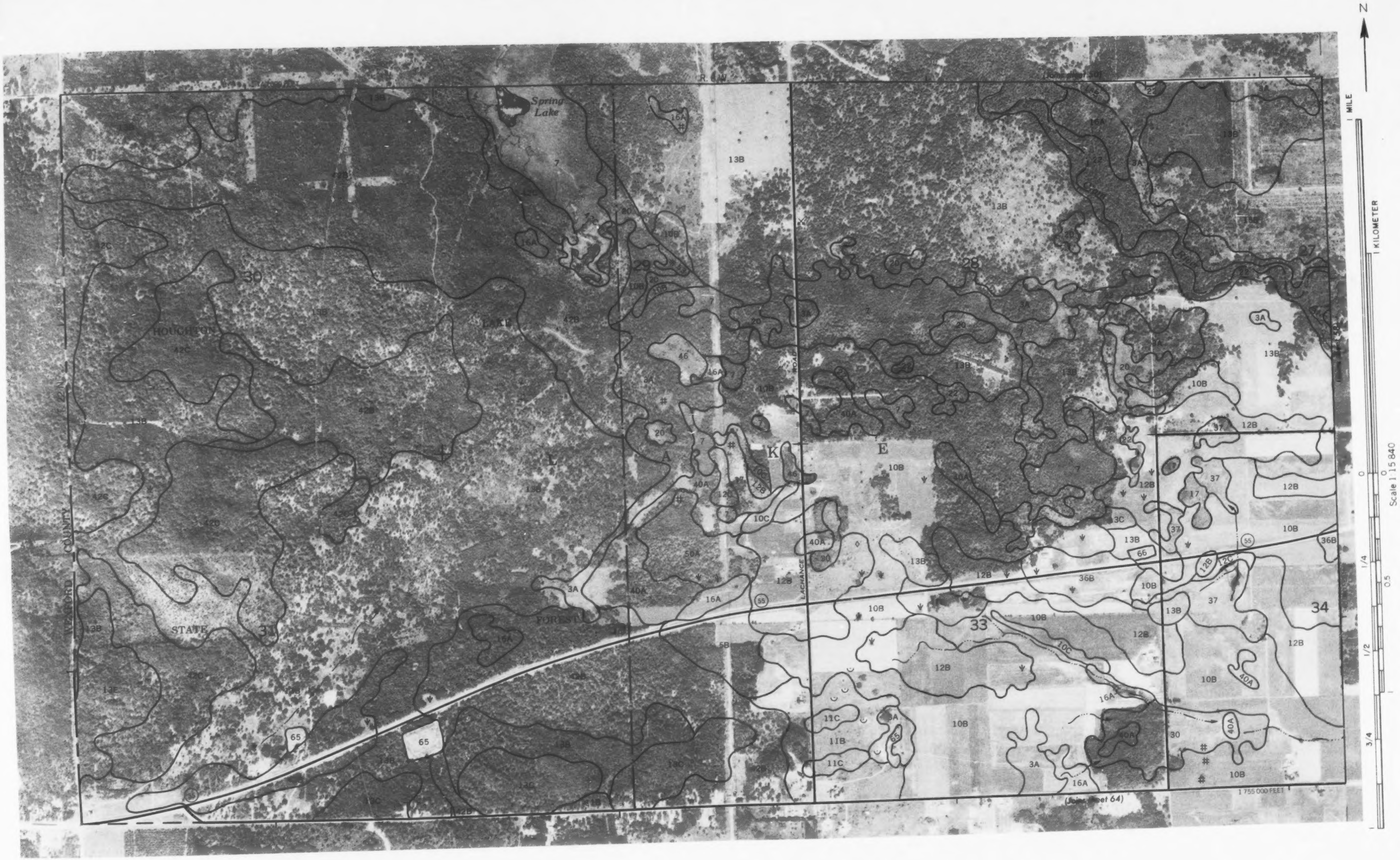
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 55


N
(Joins sheet 48)
(Joins sheet 56)
(Joins sheet 54)
(Joins sheet 62)
R. 6 W.
R. 5 W.
T. 22 N.
HOUGHTON
LAKE
FOREST
AETNA
BUTTERFIELD
13
18
17
16
24
19
20
21
ROAD
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:15 840

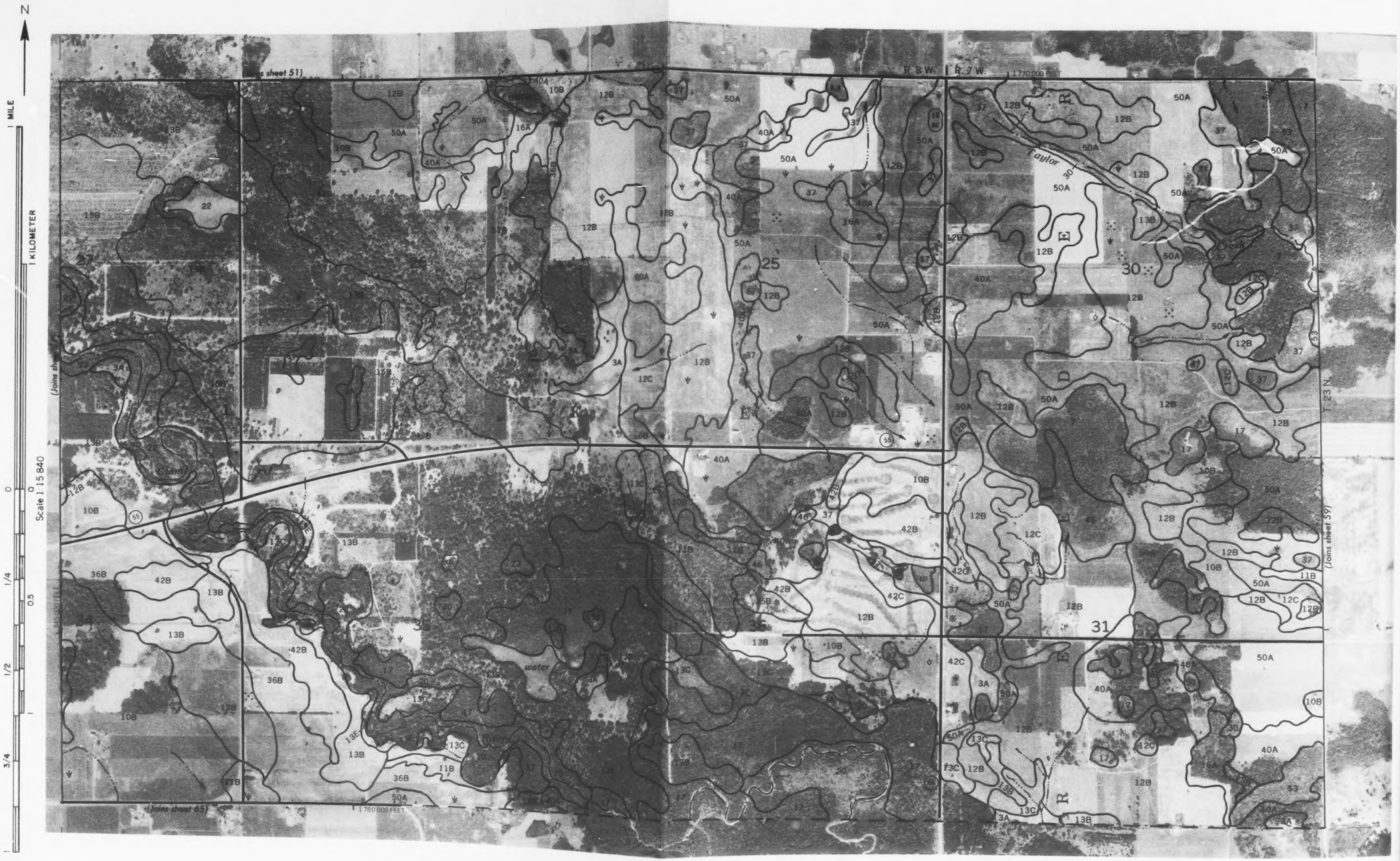
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 56


N
1 MILE
1 KILOMETER
Scale 1:15 840
R.5 W.
T.22 N.
(Joins sheet 55)
(Joins sheet 62)
15
14
13
22
23
24
B U T T E R F I E L D
HOUGHTON
LAKE
STATE
GAME
AREA
ROSCOMMON COUNTY
50A
37
12B
10B
10C
40A
53
12C
64
3A
16A
14A
22
20
7
13C

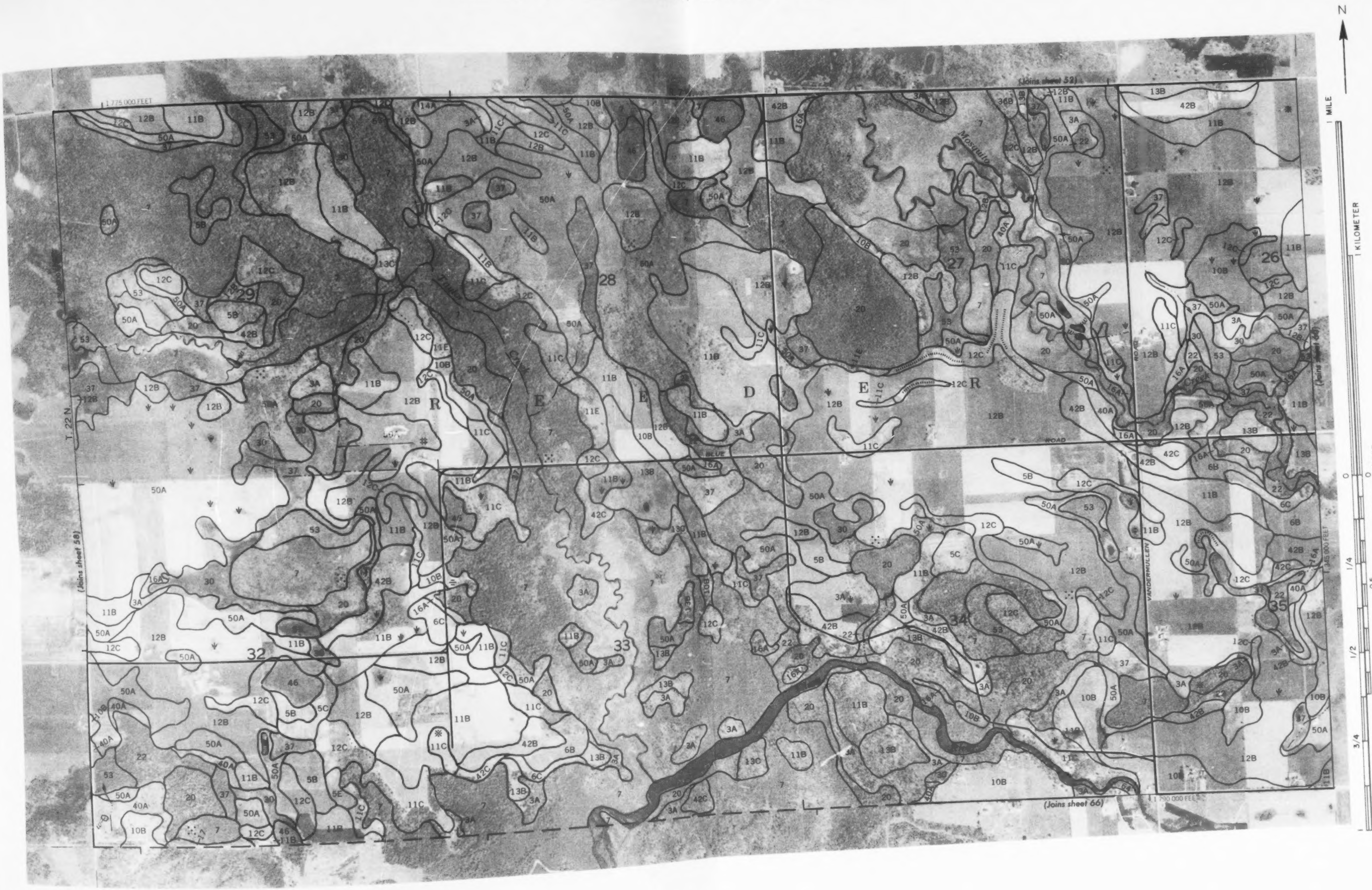
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 57


N
Spring Lake
R. 6 W.
T. 22 N.
WEXFORD COUNTY
HOUGHTON LAKE STATE FOREST
LACHANCE ROAD
K E
27
28
29
30
31
32
33
34
13B
42B
42C
7
16A
3A
20
40A
10B
10C
12B
36B
37
65
66
55
(Joins sheet 50)
(Joins sheet 64)
1 755 000 FEET
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:15 840

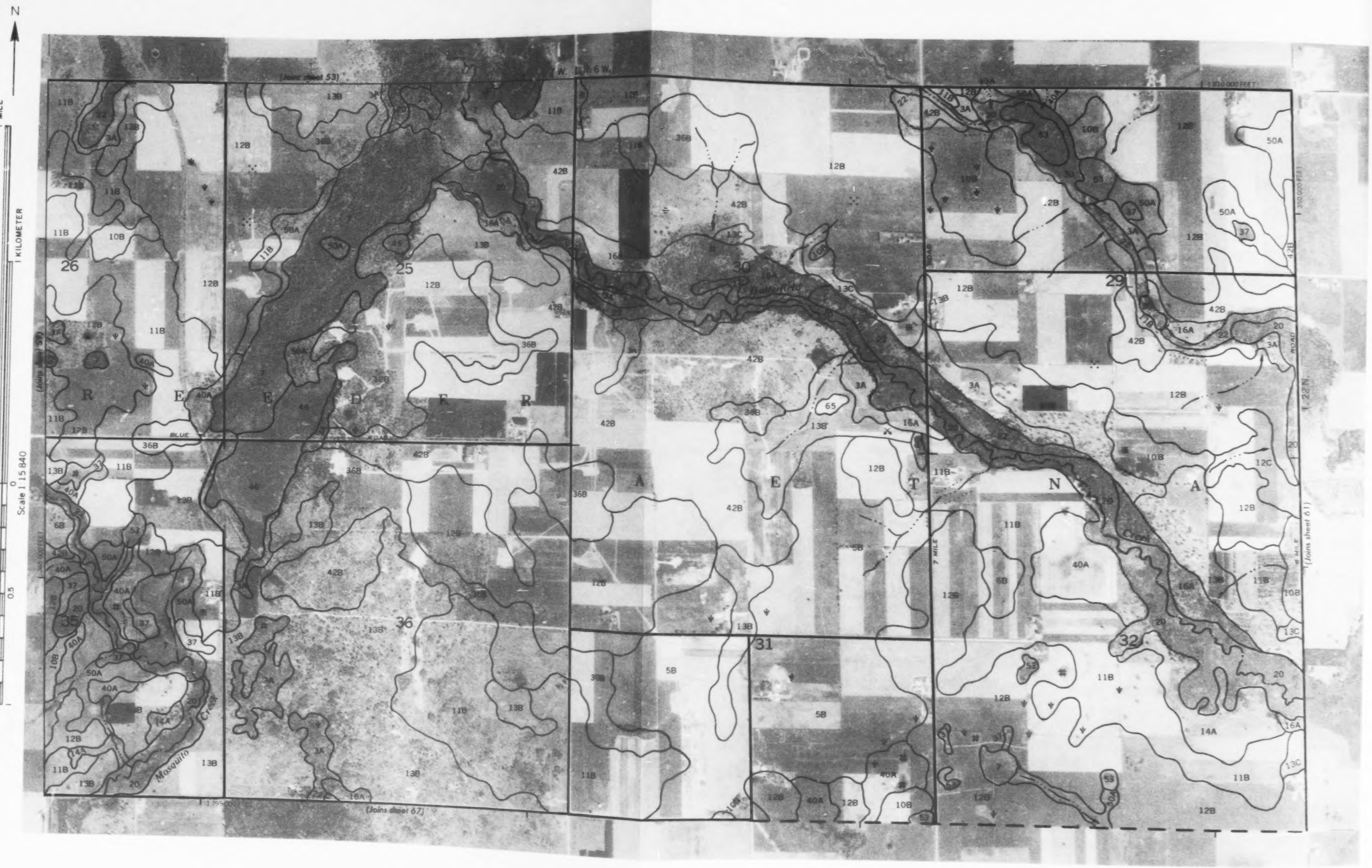
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 58


N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
0.5
1/2
1
3/4
(Joins sheet 51)
R. 8 W.
R. 7 W.
1 770 000 FEET
(Joins sheet 57)
T. 23 N.
(Joins sheet 65)
1 760 000 FEET
(Joins sheet 59)
25
26
27
30
31
35
36
34
Taylor
Clam
55
water
50A
12B
12C
10B
37
40A
13B
13C
16A
17
42B
42C
36B
46
53
11B
3A
20
22

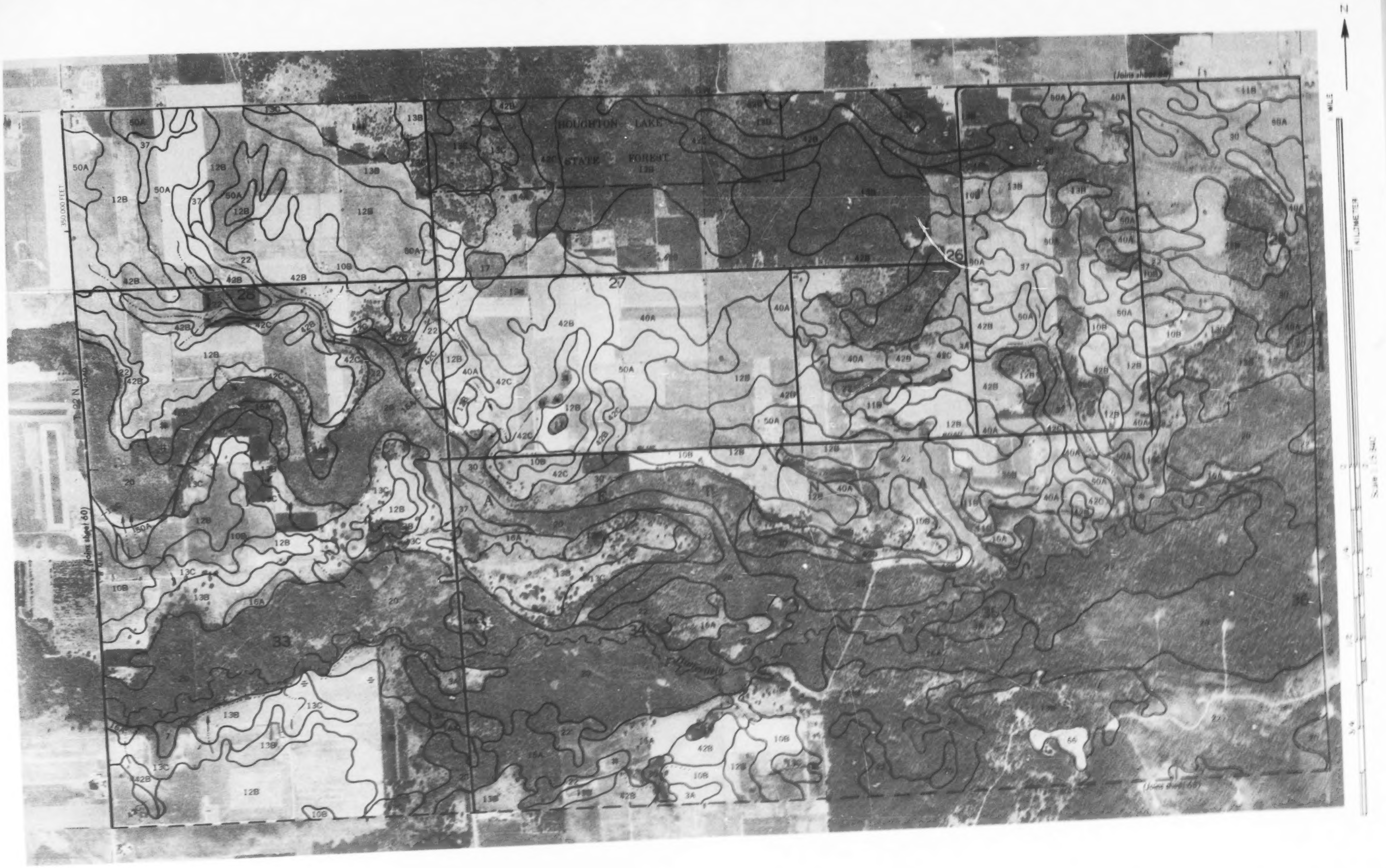
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 59


N
(Joins sheet 52)
(Joins sheet 58)
(Joins sheet 66)
(Joins sheet 60)
1 775 000 FEET
1 790 000 FEET
T. 22 N.
R E E D E R
Clam
Mosquito
BLUE
ROAD
VANDERMULLEN
26
27
28
29
32
33
34
35
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:15 840

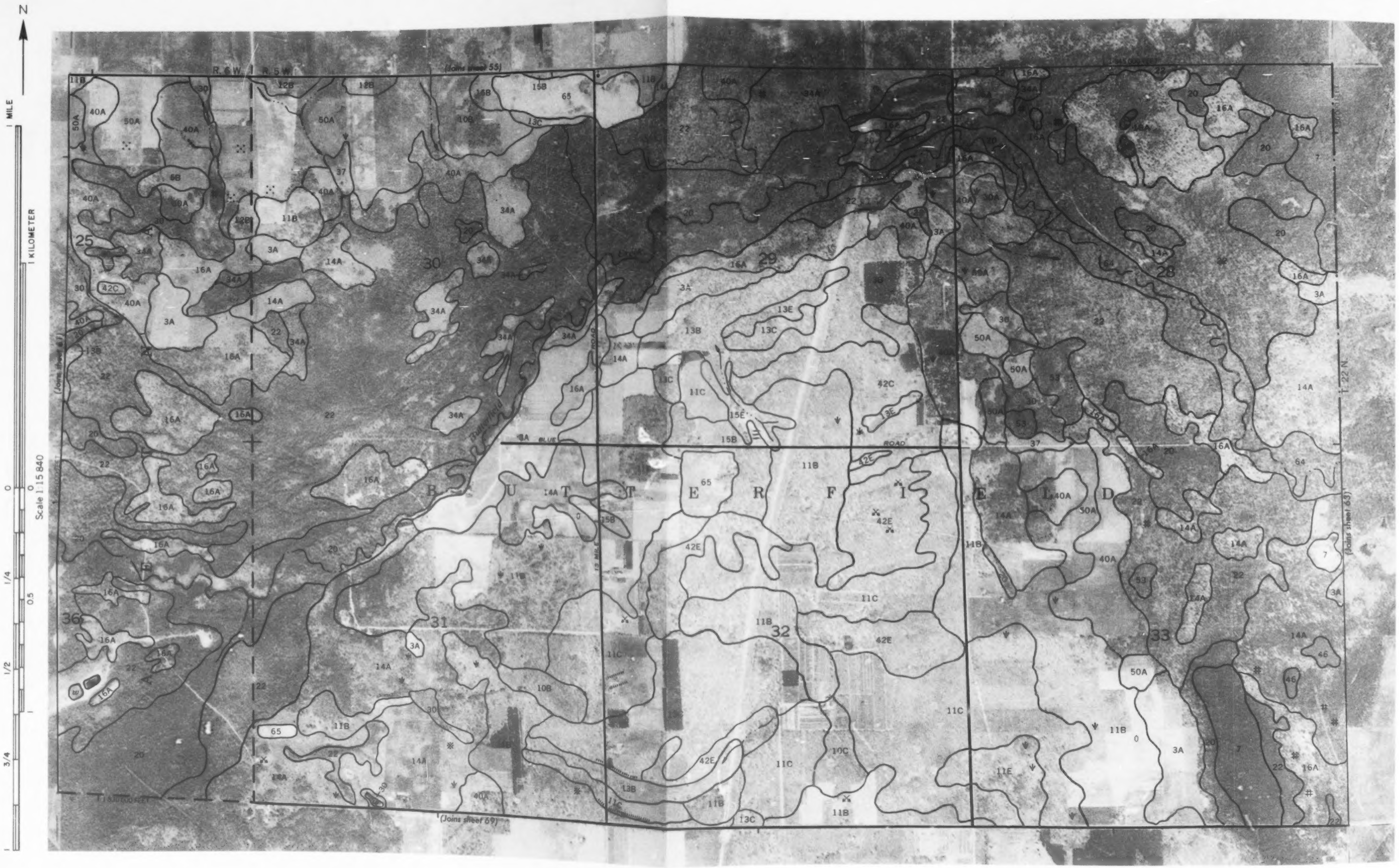
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 60


N
MILE
1 KILOMETER
0
0.5
1
Scale 1:15 840
(Joins sheet 53)
(Joins sheet 59)
(Joins sheet 61)
(Joins sheet 67)
R. 7 W. | R. 6 W.
T. 22 N.
1 380 000 FEET
350 000 FEET
1 355 000 FEET
25
26
29
30
31
32
35
36
R E E D E R
A E T N A
BLUE ROAD
7 MILE ROAD
ROAD
Butterfield Creek
Mosquito Creek
3A
5B
6B
7
10B
11B
12B
12C
13B
13C
14A
16A
20
22
36B
37
40A
42B
46
50A
53
65

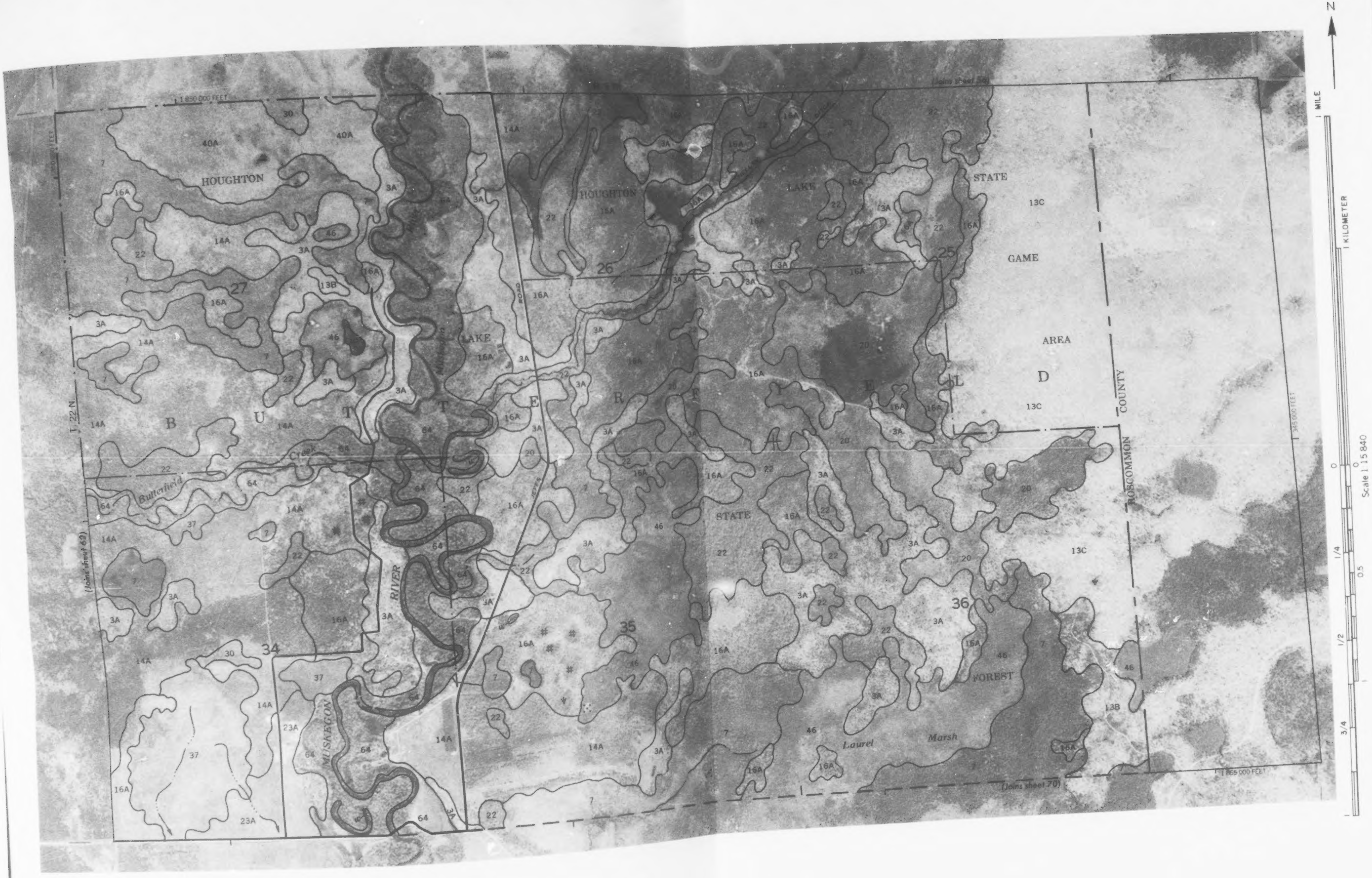
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 61


N
HOUGHTON LAKE STATE FOREST
28
27
26
33
34
35
36
T. 22 N.
350 000 FEET
(Joins sheet 60)
(Joins sheet 60)
(Joins sheet 60)
MILE
KILOMETER
50A
37
12B
13B
42B
42C
22
10B
13C
20
16A
40A
30
11B
17
3A
66

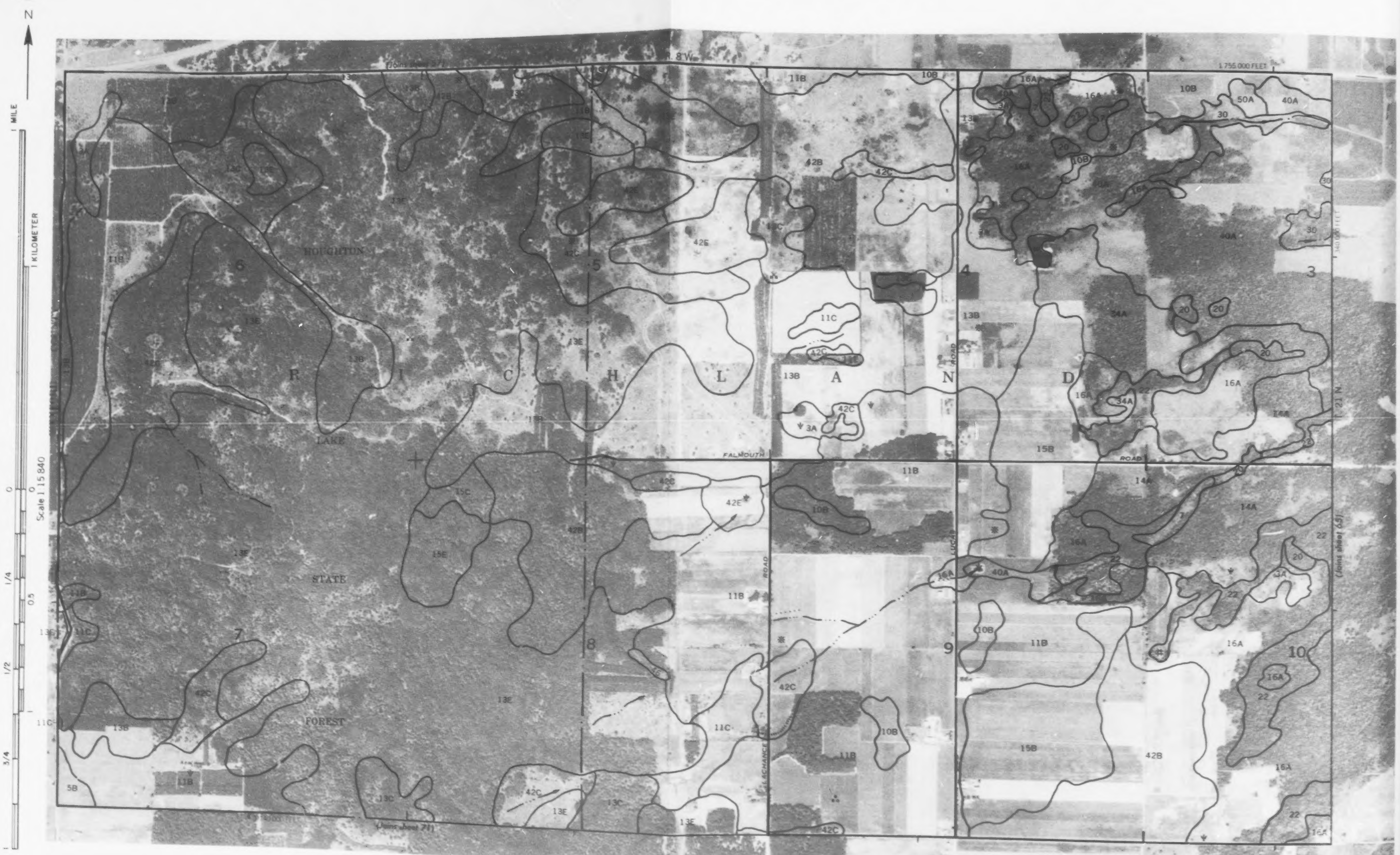
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 62


N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0
0.5
1
R. 6 W.
R. 5 W.
(Joins sheet 55)
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 69)
T. 22 N.
BUTTERFIELD
BLUE ROAD
13 MILE ROAD
ROAD
25
30
29
28
36
31
32
33
11B
12B
15B
65
13C
10B
40A
50A
30
37
6B
14A
3A
16A
34A
42C
22
20
13B
13E
11C
15E
42E
7
64
46
53
1B
10C
11E

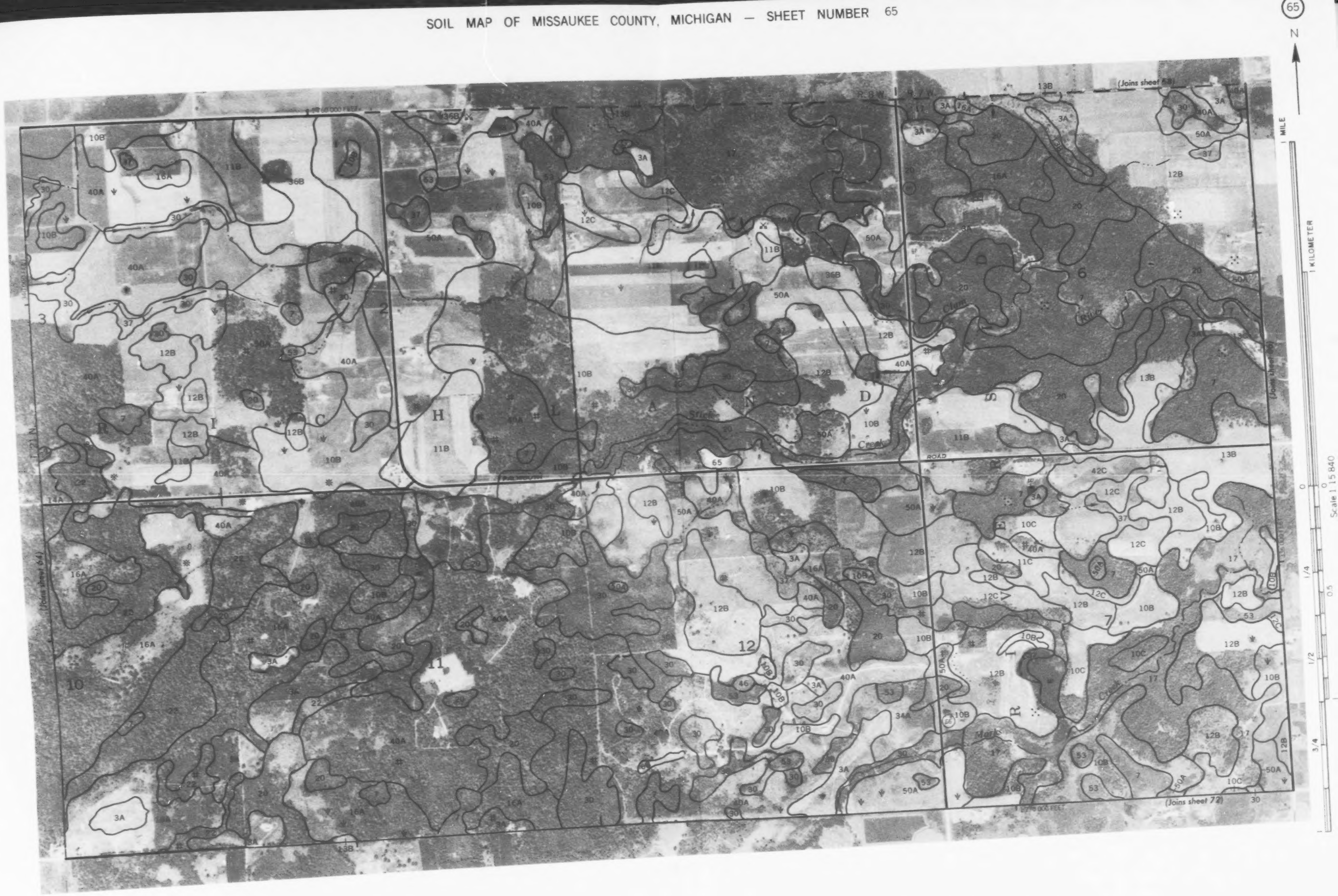
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 63


N
HOUGHTON LAKE
BUTTERFIELD STATE FOREST
STATE GAME AREA
ROSCOMMON COUNTY
MUSKEGON RIVER
Butterfield Creek
Laurel Marsh
T. 22 N.
27
26
25
34
35
36
(Joins sheet 56)
(Joins sheet 62)
(Joins sheet 70)
1 850 000 FEET
345 000 FEET
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0.5
3A
7
13B
13C
14A
16A
20
22
23A
30
37
40A
46
64

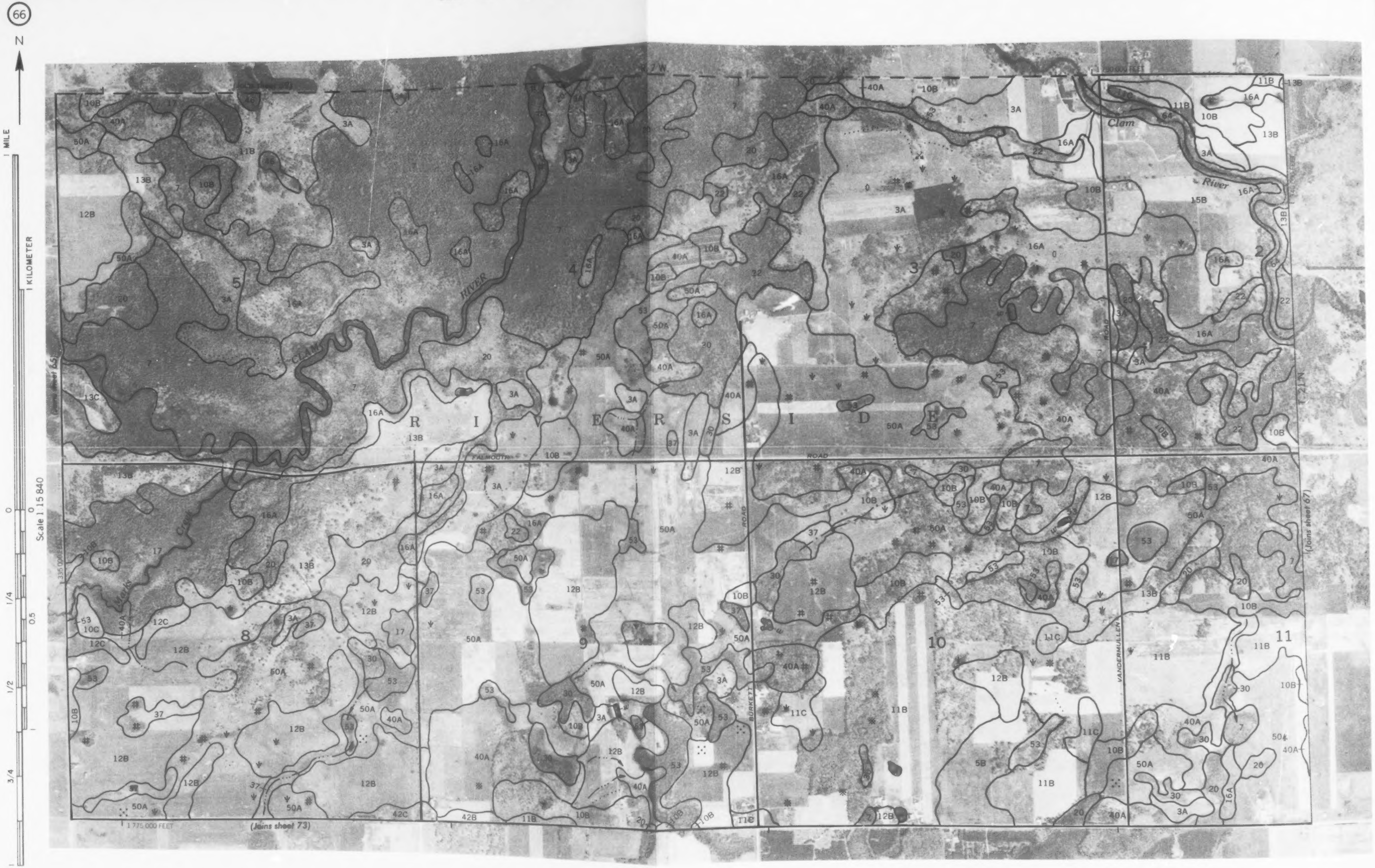
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 64


N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0
0.5
(Joins sheet 57)
(Joins sheet 71)
(Joins sheet 65)
R. 8 W.
T. 21 N.
1 755 000 FEET
340 000 FEET
HOUGHTON
LAKE
STATE
FOREST
R I C H L A N D
3
4
5
6
7
8
9
10
FALMOUTH
ROAD
ROAD
LUCAS
LACHANCE
ROAD
3A
5B
10B
11B
11C
13B
13C
13E
14A
15B
15C
15E
16A
20
22
30
34A
40A
42B
42C
42E
50A

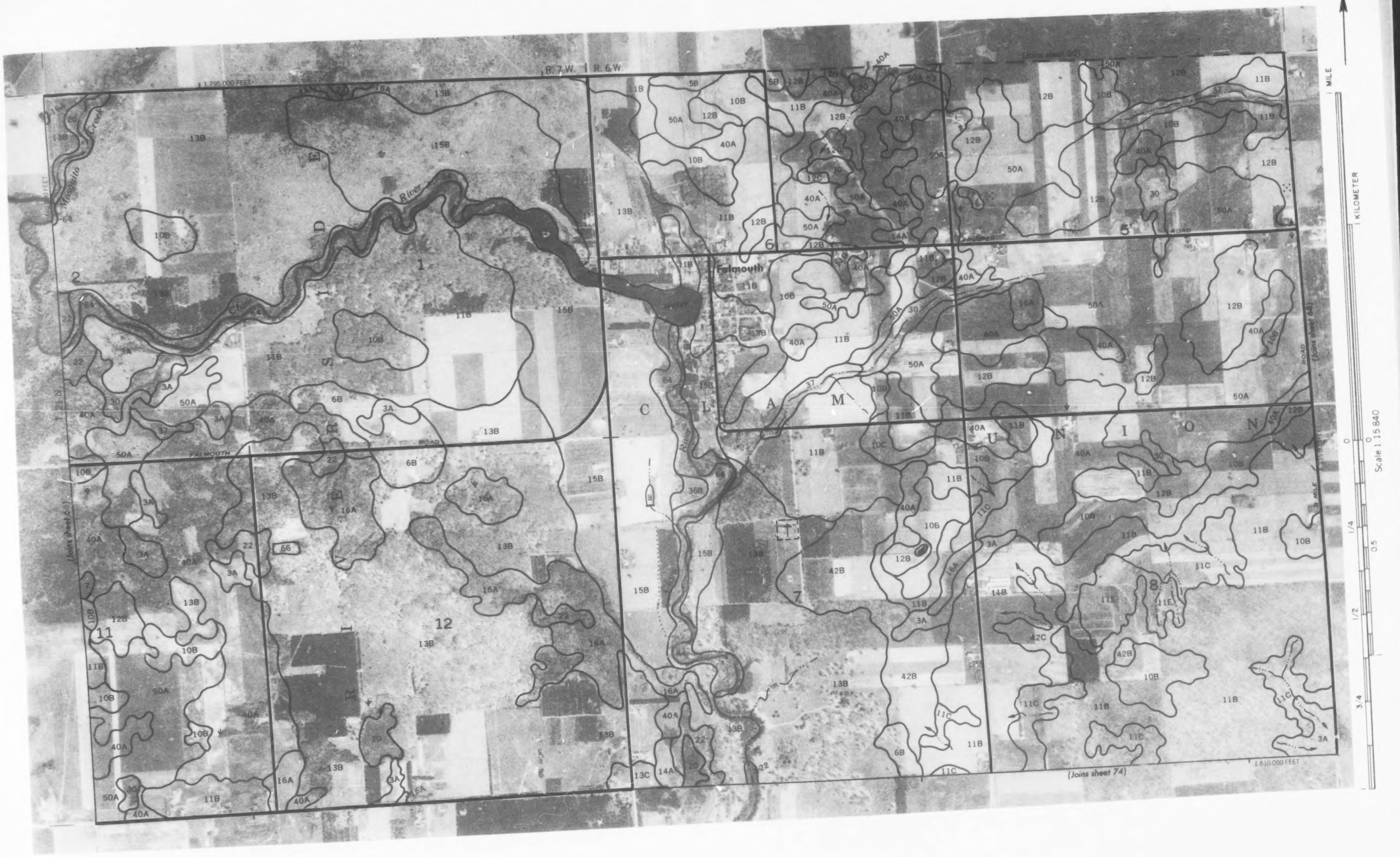
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 65


(65)
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
Scale 1:15 840
(Joins sheet 59)
(Joins sheet 66)
(Joins sheet 72)
(Joins sheet 64)
R. 8 W.
T. 21 N.
ROAD
Clam River
Stick Creek
Marks Creek
3
2
1
6
5
4
7
8
9
10
11
12
13B
10B
11B
12B
12C
16A
3A
20
22
30
36B
37
40A
50A
53
63
65
42C
10C
11C
17
46
34A

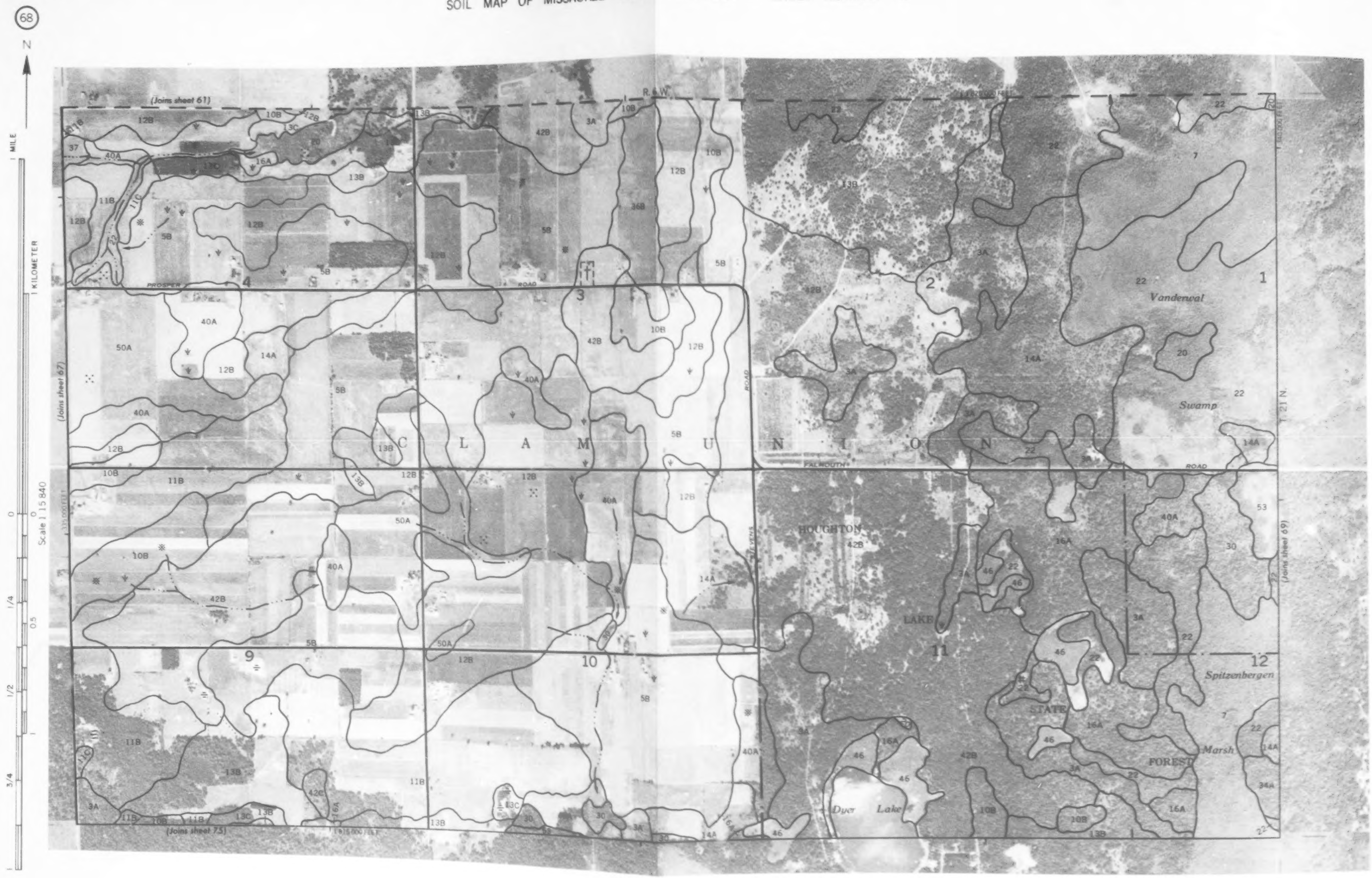
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 66

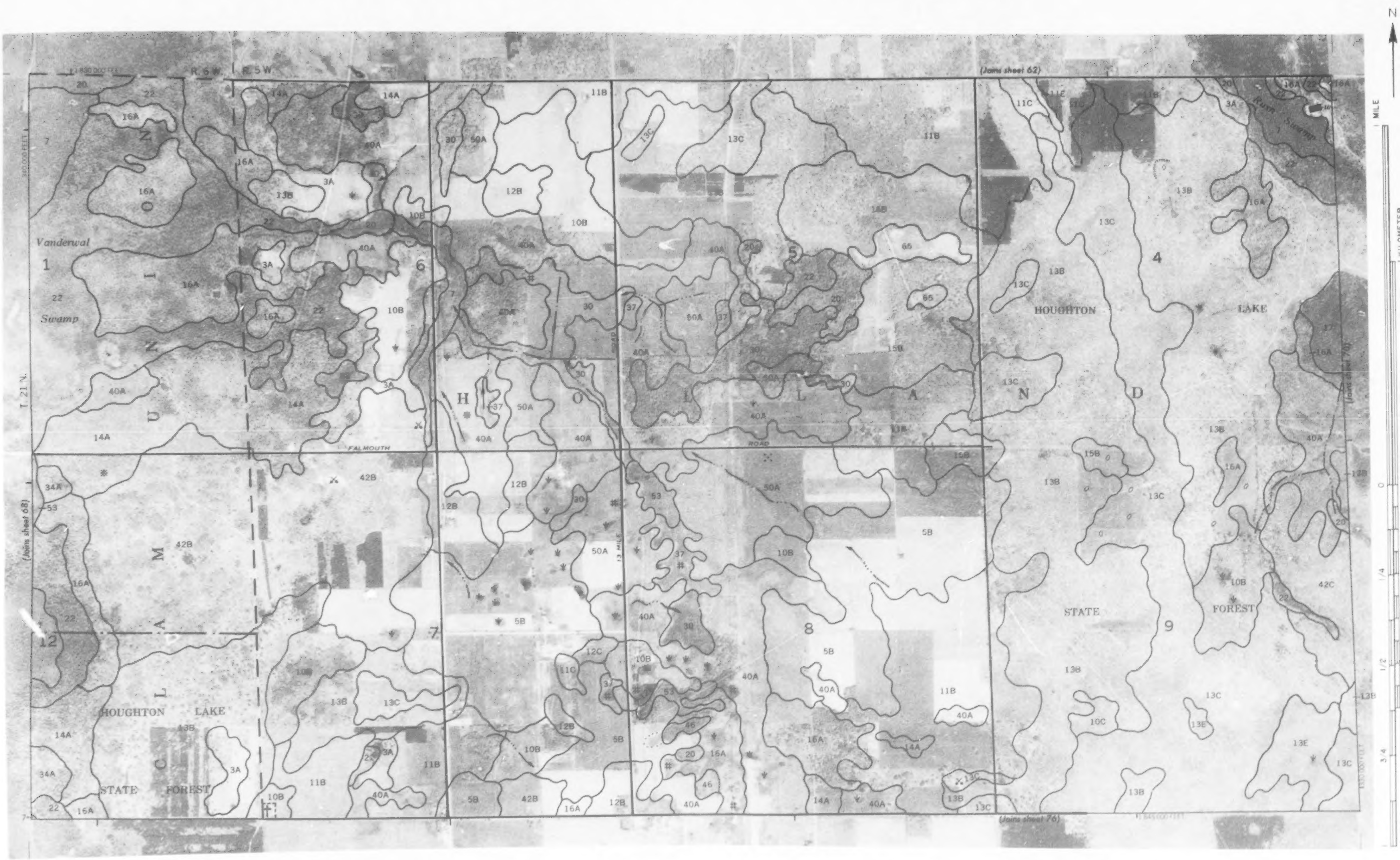

66
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
R 7 W
T 21 N
Clam River
RIVERSIDE
FALMOUTH ROAD
BURKETT ROAD
VANDERMULLEN ROAD
(Joins sheet 65)
(Joins sheet 67)
(Joins sheet 73)
1 775 000 FEET
135 000 FEET
2
3
4
5
8
9
10
11

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 67


N
(Joins sheet 60)
(Joins sheet 74)
(Joins sheet 66)
(Joins sheet 65)
R. 7 W. | R. 6 W.
T. 21 N.
1 795 000 FEET
1 810 000 FEET
Falmouth
Mosquito Creek
Clam River
FALMOUTH ROAD
PROSPER ROAD
ROAD
R I C H F I E L D
C L A M
U N I O N
1
2
5
6
7
8
11
12
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:15 840
13B
15B
10B
11B
12B
50A
40A
3A
16A
22
30
37
64
6B
42B
42C
11C
11E
20
14A
13C
36B
5B
1B
12C
10C
66

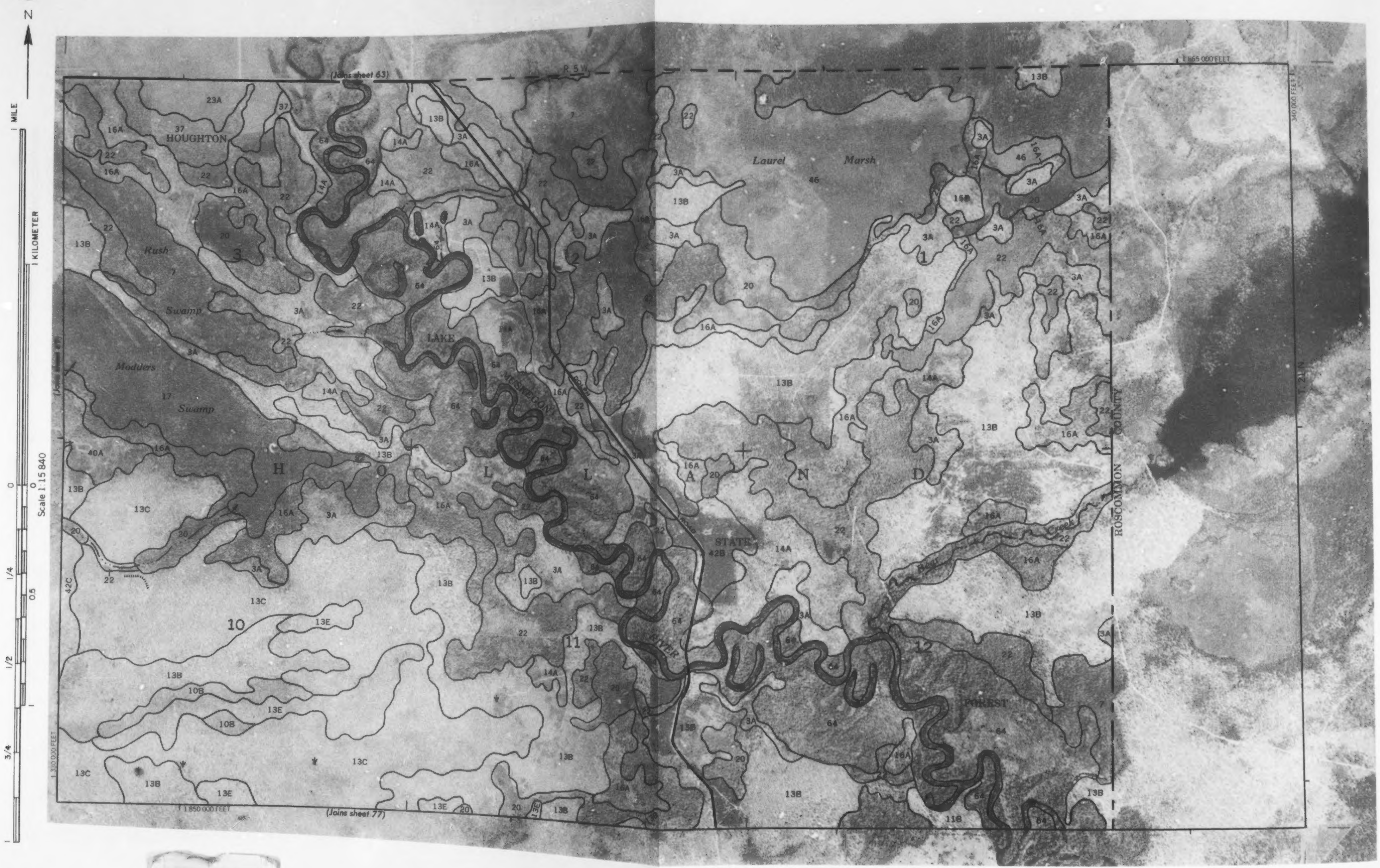
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 68


68
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 61)
(Joins sheet 67)
(Joins sheet 69)
(Joins sheet 75)
R. 6 W.
T. 21 N.
PROSPER ROAD
FALMOUTH ROAD
STEVENS ROAD
ROAD
C L A M U N I O N
HOUGHTON LAKE STATE FOREST
Vanderwal Swamp
Spitzenbergen Marsh
Dyer Lake
1
2
3
4
9
10
11
12
5B
12B
10B
11B
11C
13B
13C
14A
16A
17C
20
22
3A
30
34A
36B
37
40A
42B
42C
46
50A
53
7


69
N
(Joins sheet 62)
(Joins sheet 68)
(Joins sheet 70)
(Joins sheet 76)
R. 6 W.
R. 5 W.
T. 21 N.
1 850 000 FEET
350 000 FEET
Vanderwal
Swamp
Rum
Swamp
U N I O N
H O L L A N D
C L A M
HOUGHTON LAKE
STATE FOREST
HOUGHTON
LAKE
STATE
FOREST
FALMOUTH
ROAD
ROAD
13 MILE
1
4
5
6
7
8
9
12
1 MILE
KILOMETER
0
1/4
1/2
3/4

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 70

(70)



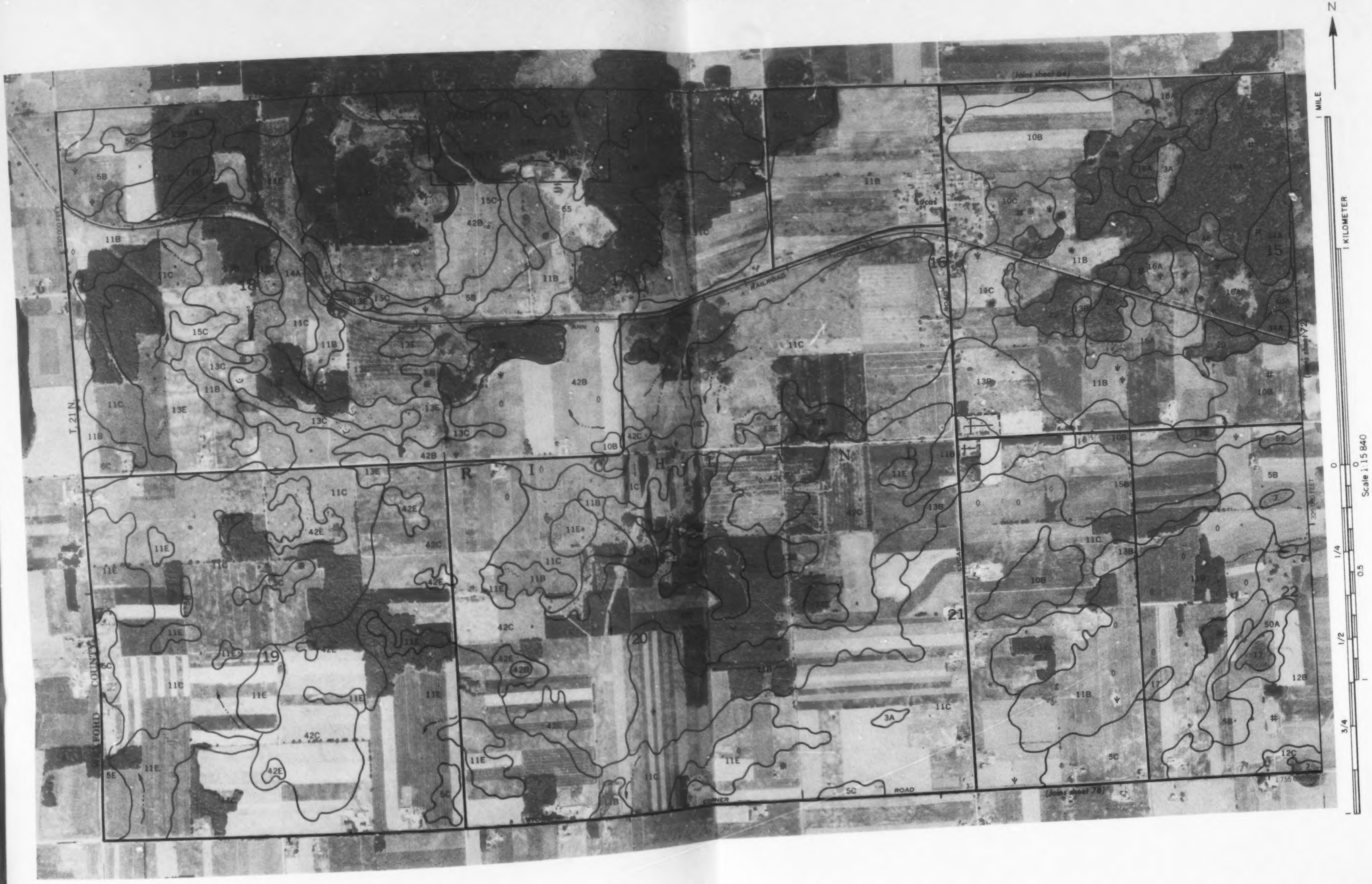
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0
0.5
1
(Joins sheet 63)
(Joins sheet 77)
(Joins sheet 69)
R 5 W
1 865 000 FEET
340 000 FEET
1 850 000 FEET
1 330 000 FEET
T 22 N
HOUGHTON
LAKE
STATE
FOREST
Rush
Swamp
Modders
Swamp
Laurel
Marsh
MUSKEGON
RIVER
Reedy
Creek
ROSCOMMON COUNTY
H
O
L
L
A
N
D
1
2
3
10
11
12
23A
37
16A
22
13B
14A
3A
18A
20
64
7
46
42B
40A
13C
42C
10B
13E
17
11B
13D

This soil survey map is compiled on 1980 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

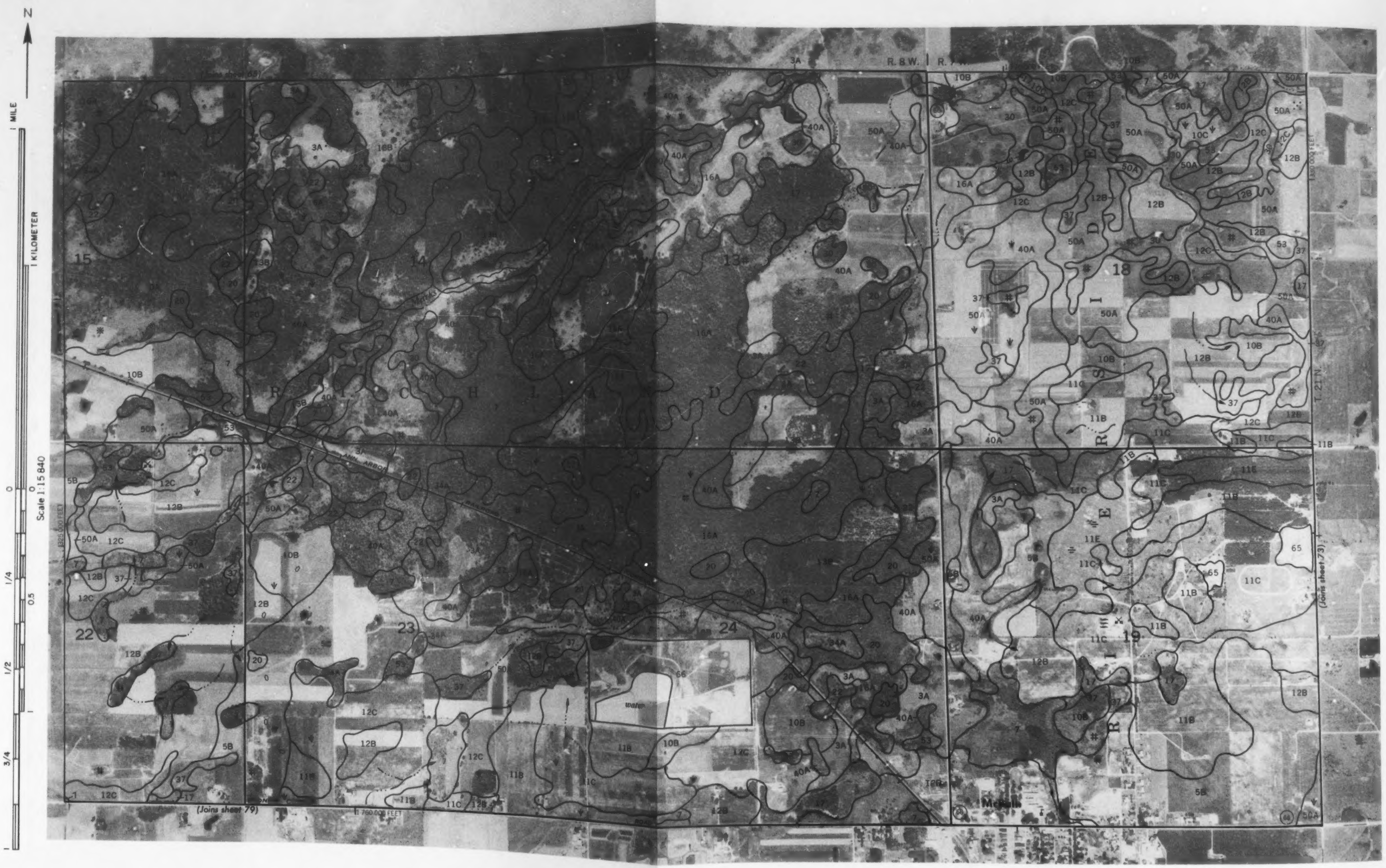
Coordinate grid ticks and land division corners

READEX FICHE

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 71

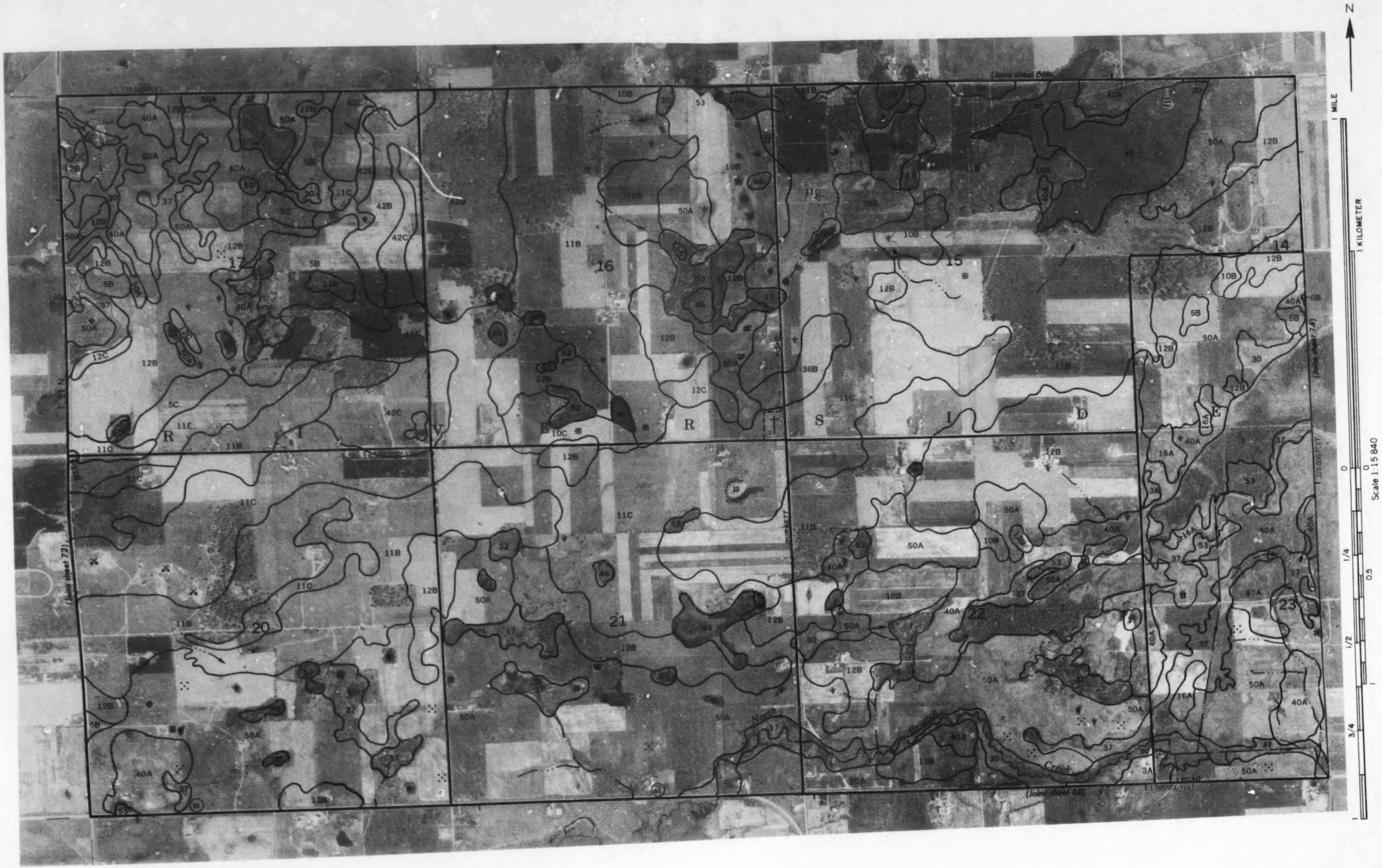

N
(Joins sheet 64)
(Joins sheet 72)
(Joins sheet 78)
T. 21 N.
WEXFORD COUNTY
R I C H L A N D
RAILROAD
CORNER
ROAD
15
16
17
18
19
20
21
22
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0
0.5
1
Scale 1:15 840
5B
5C
10B
10C
11B
11C
11E
13B
13C
13E
15B
15C
16A
3A
42B
42C
42E
50A
12B
12C
65

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 72

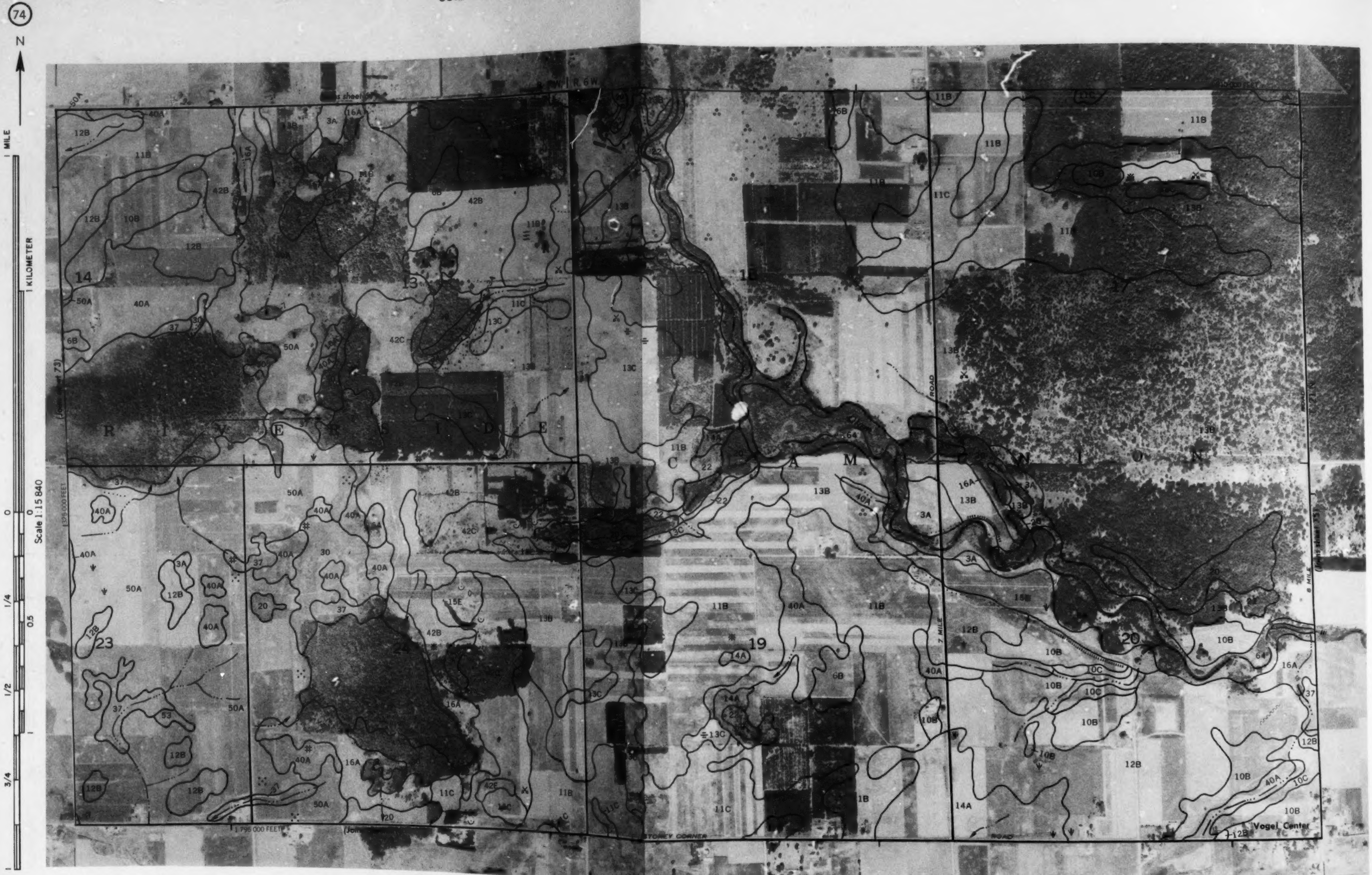

N
MILE
KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
R. 8 W.
R. 7 W.
T. 21 N.
15
14
13
18
22
23
24
19
R I C H L A N D
ANN ARBOR
(Joins sheet 79)
(Joins sheet 73)
McBain
3A
10B
11B
11C
12B
12C
16A
40A
50A
5B
17
20
37
53
65
66

This soil survey map is compiled on 1980 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 73


N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0.5
1
(Joins sheet 66)
(Joins sheet 72)
(Joins sheet 74)
(Joins sheet 80)
14
15
16
17
20
21
22
23
R
I
V
E
R
S
I
D
E
North Branch Creek
ROAD

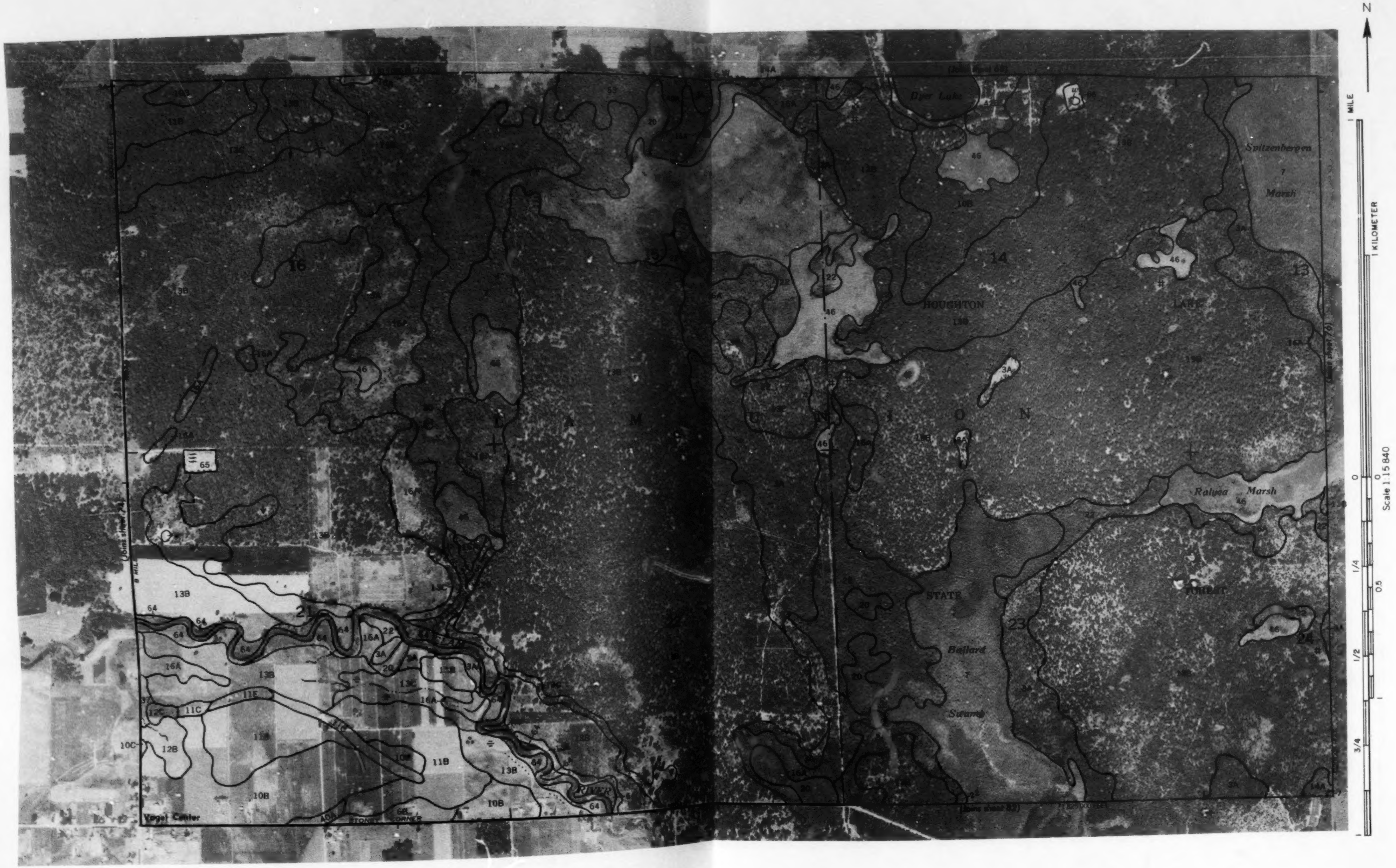
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 74



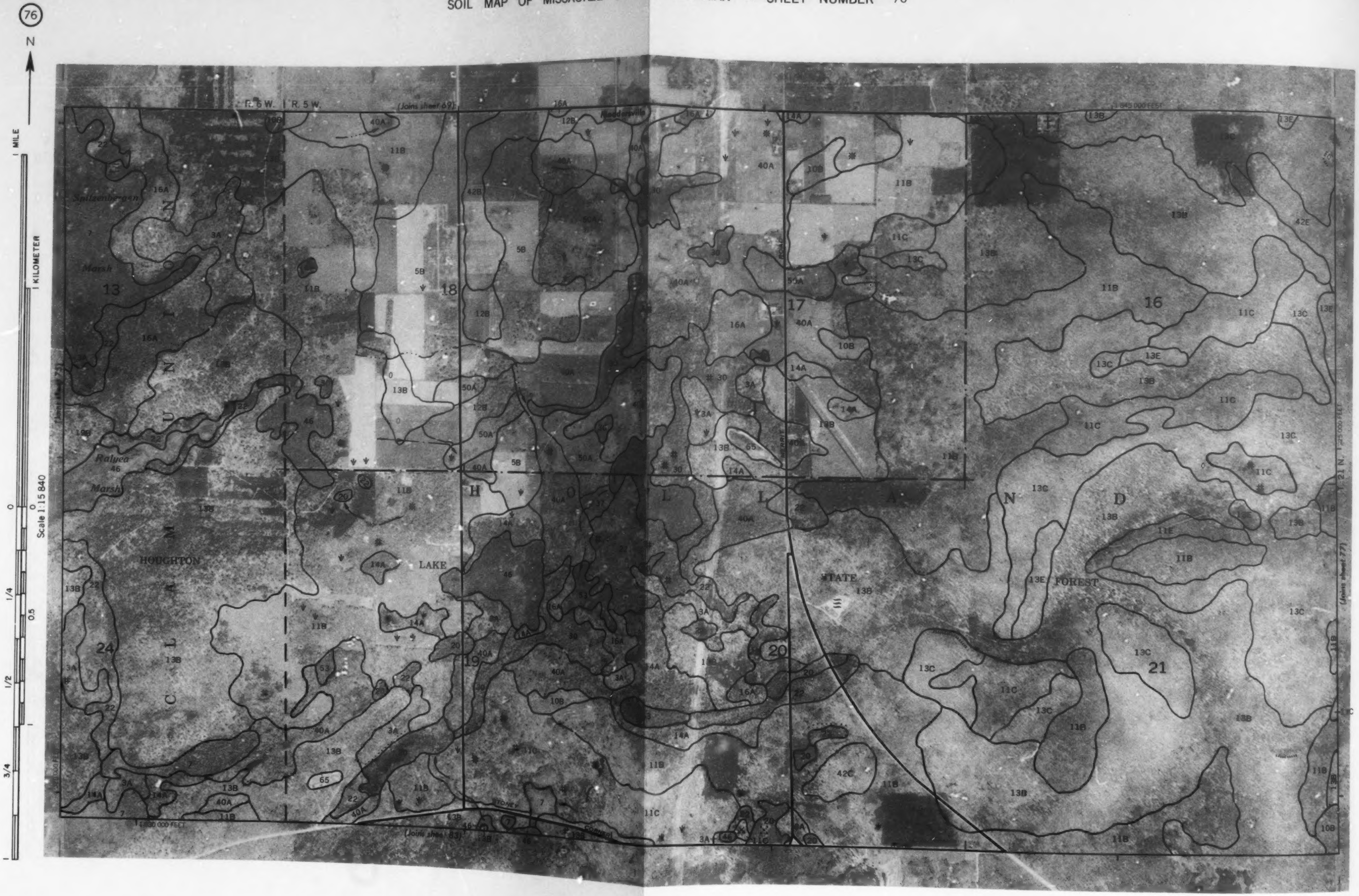
74
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
R I V E R S I D E
C L A M U N I O N
R 6 W | R 5 W
14
13
18
17
23
24
19
20
Vogel Center
STOREY CORNER
7 MILE ROAD
8 MILE ROAD
ROAD
(Joins sheet 73)
(Joins sheet 73)
(Joins sheet 73)
1 796 000 FEET
175 000 FEET
40 000 FEET
3A
6B
10B
10C
11B
11C
12B
13B
13C
14A
15E
16A
20
22
30
37
40A
42B
42C
42E
50A
53
64

This soil survey map is compiled on 1980 aerial photography by the U.S.
Coordinate grid ticks and land division corners

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 75


Dyer Lake
Spitzenbergen Marsh
Ralyea Marsh
Ballard Swamp
HOUGHTON LAKE STATE FOREST
C L A M
U N I O N
16
15
14
13
21
22
23
24
RIVER
Vogel Center
STONE CORNER
13B
16A
46
3A
64
10B
11B
12B
11C
11E
10C
65
20
22
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0.5

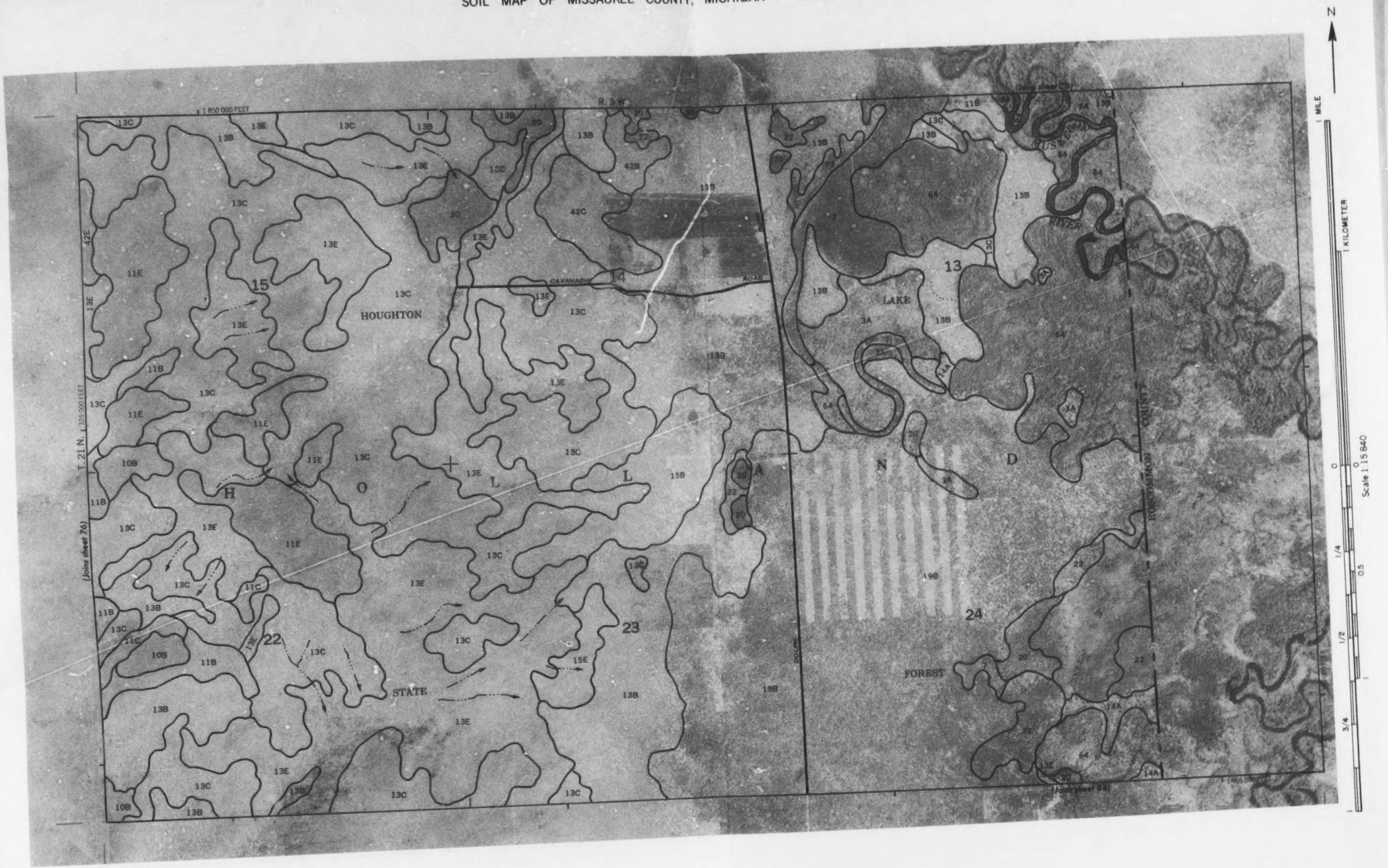
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 76



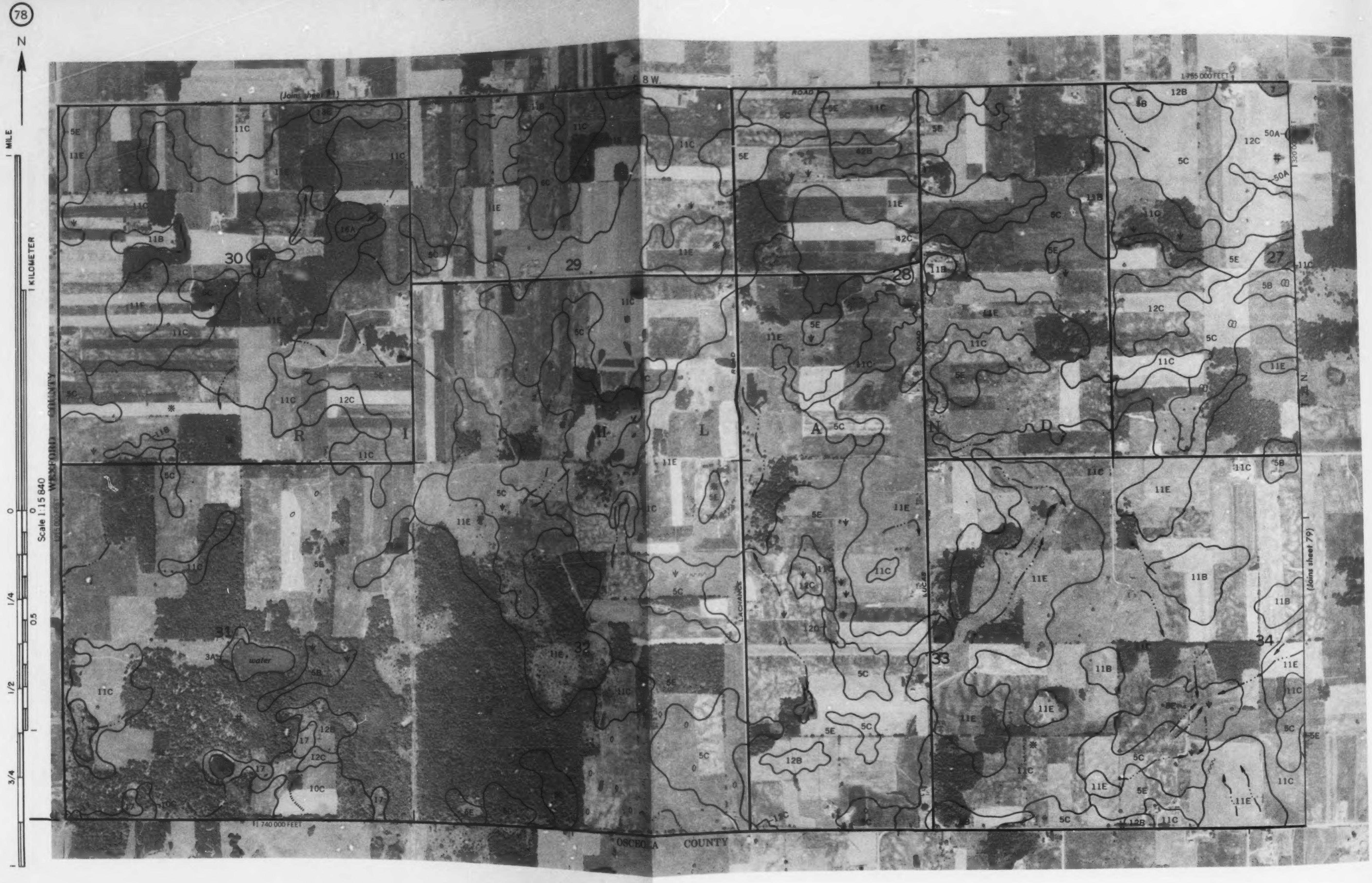
76
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0.5
R. 6 W.
R. 5 W.
(Joins sheet 69)
(Joins sheet 77)
(Joins sheet 83)
T. 21 N.
Spitzenbergen
Marsh
Ralyea
Marsh
HOUGHTON
LAKE
STATE
FOREST
CLAM
UNION
HOLLAND
13
18
17
16
24
19
20
21
16A
3A
13B
11B
11C
13C
13E
40A
5B
50A
12B
10B
14A
22
46
42C
42E
65
7

This soil survey map is compiled on 1980 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 77


N
R. 5 W.
1 850 000 FEET
T. 21 N.
325 000 FEET
(Joins sheet 76)
(Joins sheet 70)
(Joins sheet 84)
CAVANAGH ROAD
MUSKEGON RIVER
ROSCOMMON COUNTY
HOUGHTON LAKE STATE FOREST
15
14
13
22
23
24
13C
13B
13E
11E
11B
11C
10B
42E
42B
42C
20
22
64
7
3A
14A
15B
15E
19B
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0.5
1

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 78

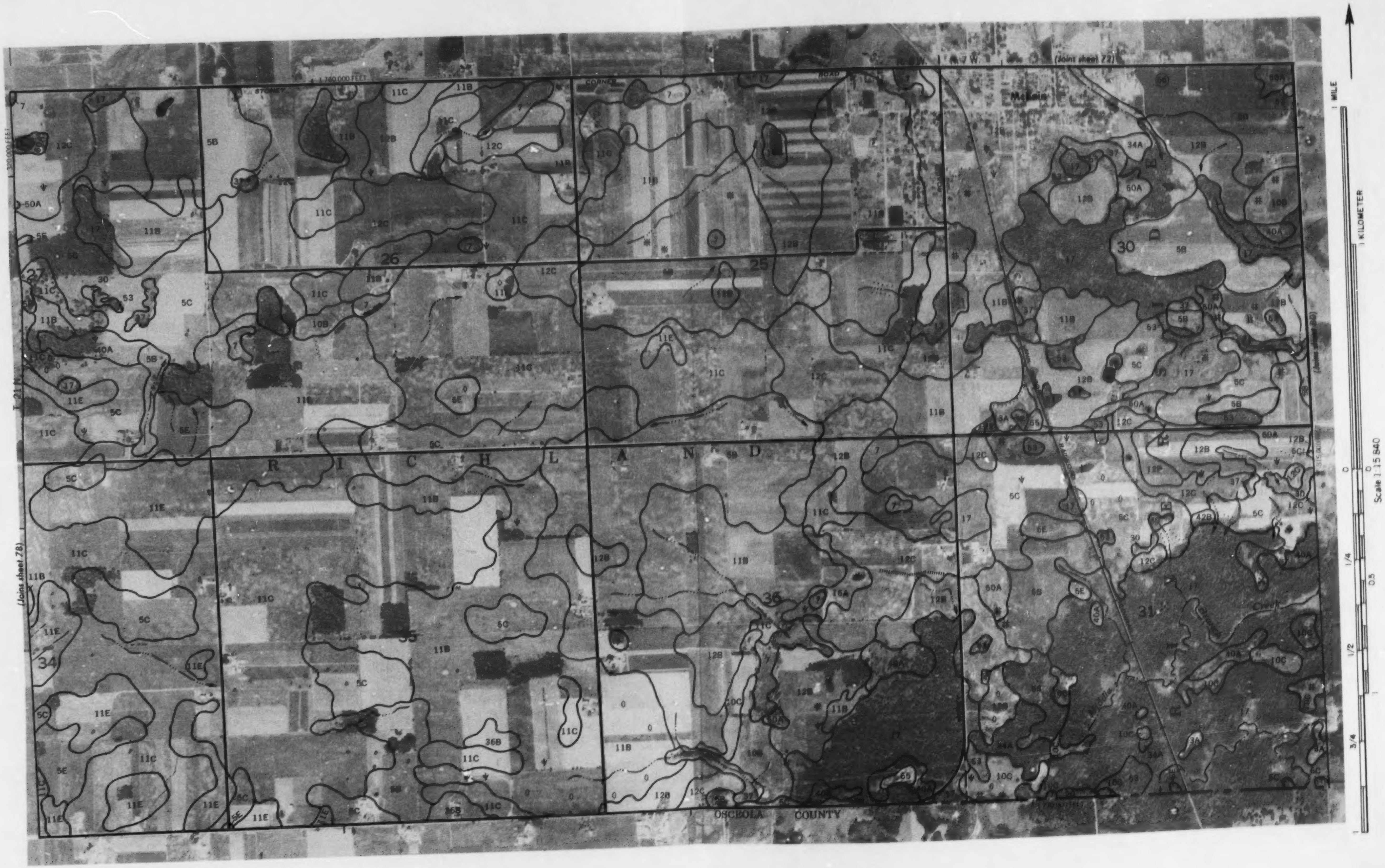


78
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
1
Scale 1:15 840
(Joins sheet 71)
(Joins sheet 79)
R. 8 W.
T. 21 N.
1 755 000 FEET
1 740 000 FEET
320 000
WEXFORD COUNTY
OSCEOLA COUNTY
ROAD
R
I
C
H
L
A
N
D
27
28
29
30
31
32
33
34
water
3A
5B
5C
5E
10C
11B
11C
11E
12B
12C
16A
17
50A

This soil survey map is compiled on 1980 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

Coordinate grid ticks and land division corners, if shown, are approximately positioned.

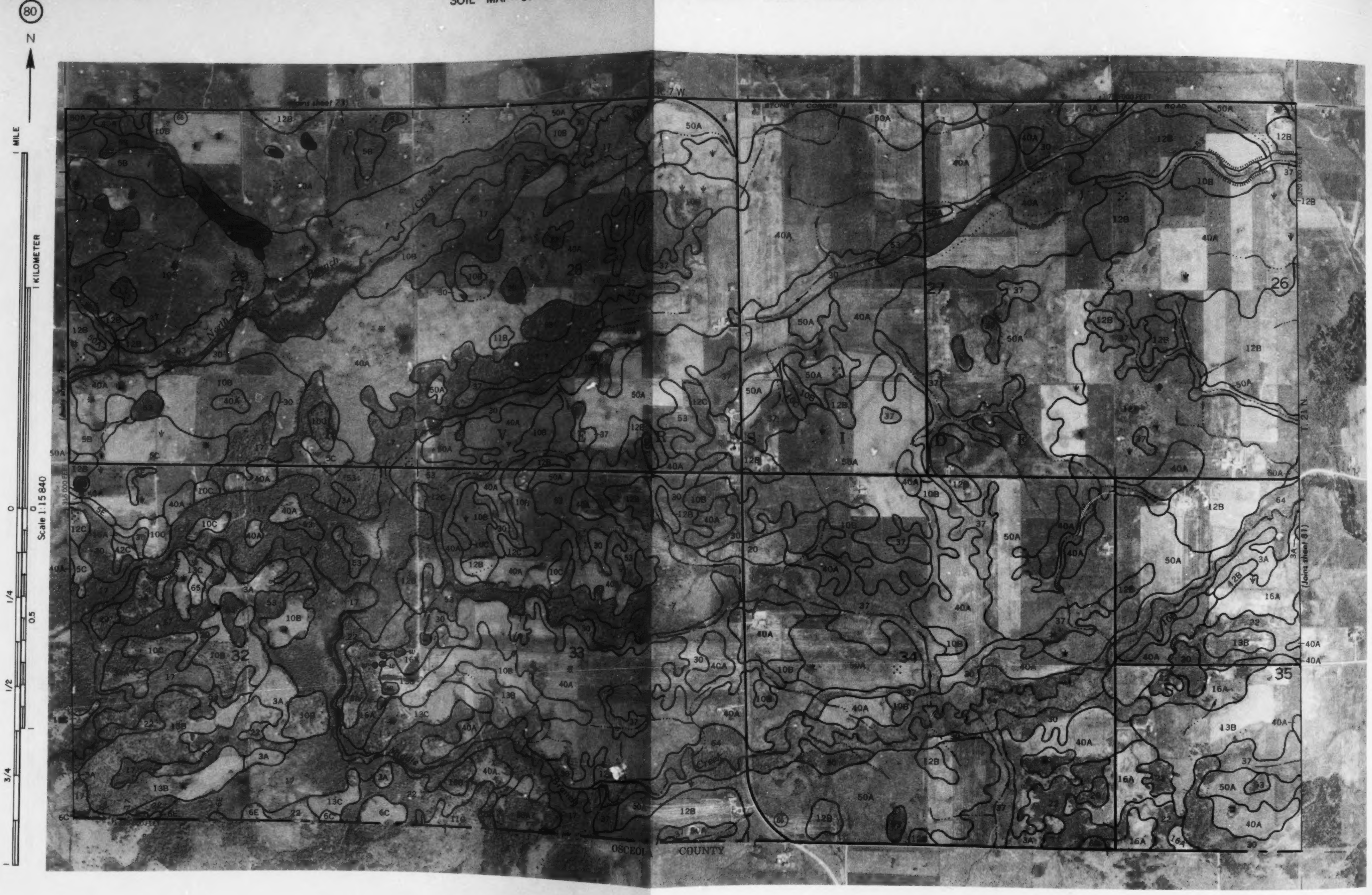
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 79


N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0.5
(Joins sheet 72)
(Joins sheet 78)
(Joins sheet 80)
R. 7 W.
T. 21 N.
1 760 000 FEET
320 000 FEET
McBain
STONEY
CORNERS
ROAD
R I C H L A N D
OSCEOLA COUNTY
25
26
27
30
31
34
35
36
Creek

This soil survey map is compiled on 1980 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

Coordinate grid ticks and land division corners, if shown, are approximately positioned.

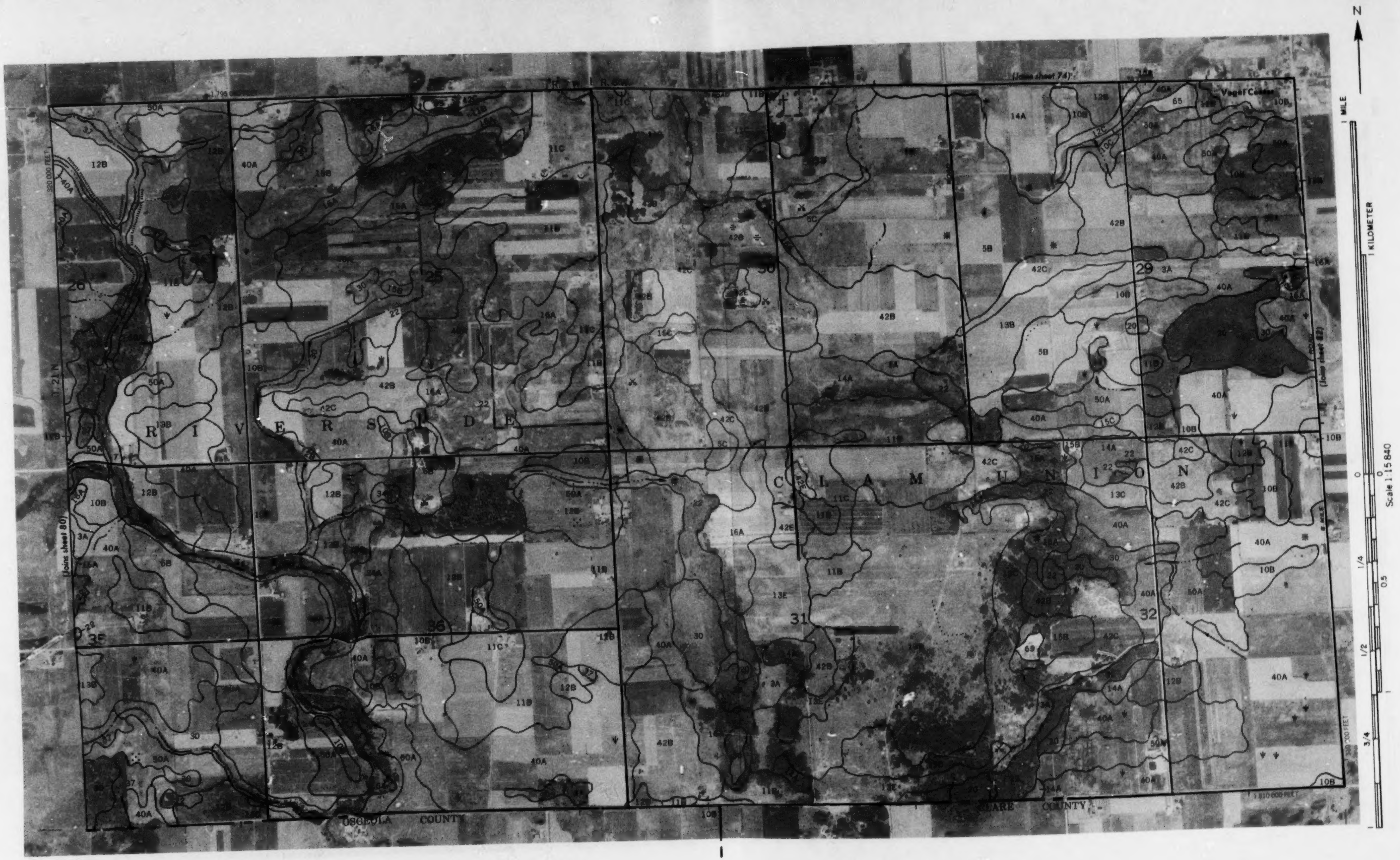
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 80



80
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:15 840
(Joins sheet 73)
(Joins sheet 81)
R. 7 W.
T. 21 N.
STONEY CORNER
ROAD
North Branch Creek
Creek
OSCEOLA COUNTY
26
27
28
29
32
33
34
35

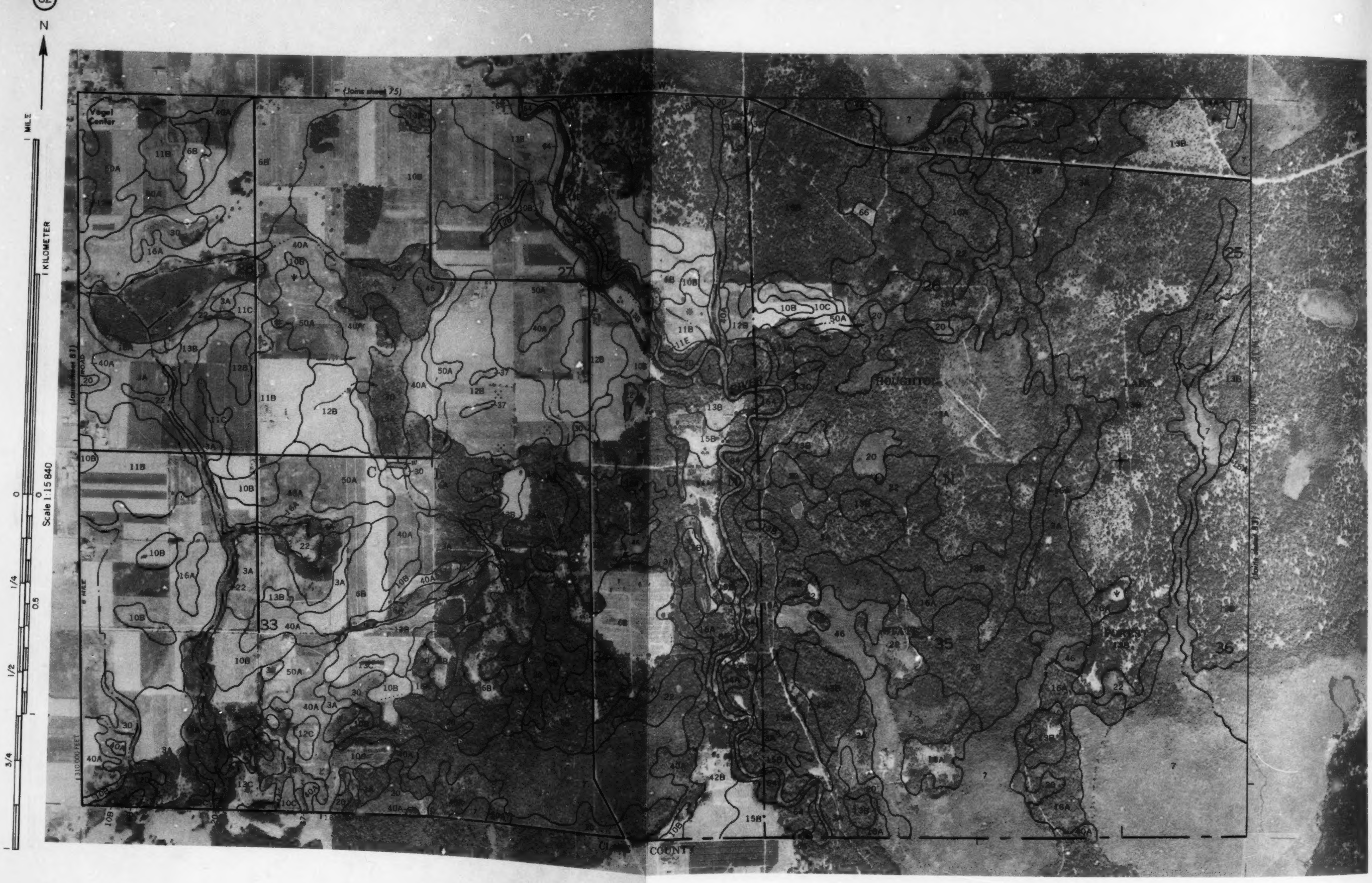
This soil survey map is compiled on 1980 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 81


R I V E R S I D E
C L A M U N I O N
26
25
30
29
35
36
31
32
T. 21 N.
R. 7 W.
R. 6 W.
(Joins sheet 74)
(Joins sheet 80)
(Joins sheet 82)
Vogel Center
OSCEOLA COUNTY
CLARE COUNTY
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
0.5
1
5 000 FEET

This soil survey map is compiled on 1980 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
[illegible]

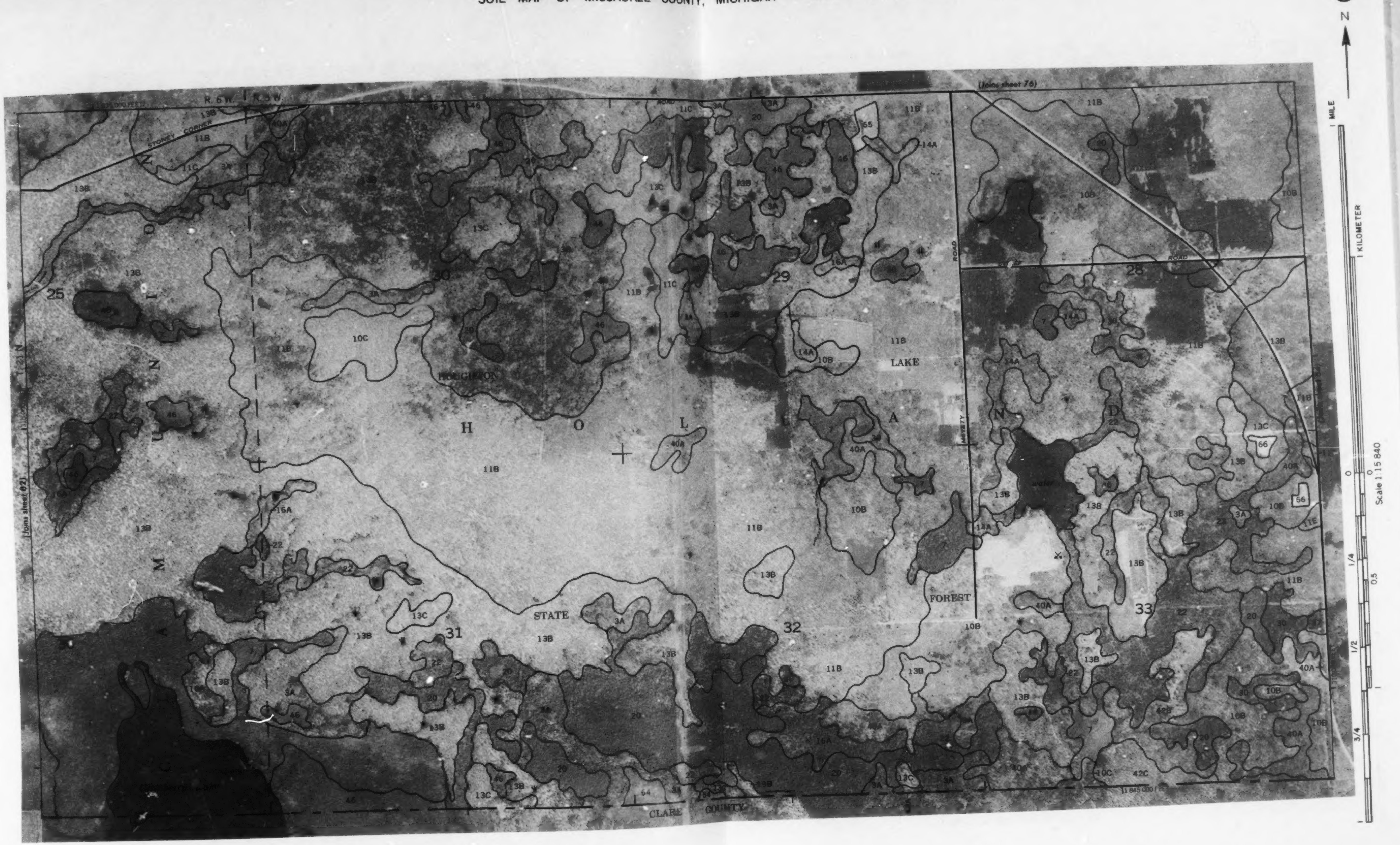
SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 82


N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 75)
(Joins sheet 81)
(Joins sheet 83)
Vogel Center
ROAD
RIVER
HOUGHTON
LAKE
COUNTY
1 310 000 FEET
27
26
25
33
34
35
36
10B
11B
6B
40A
50A
13B
16A
22
3A
12B
30
20
7
15B
42B

This soil survey map is compiled on 1980 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 83

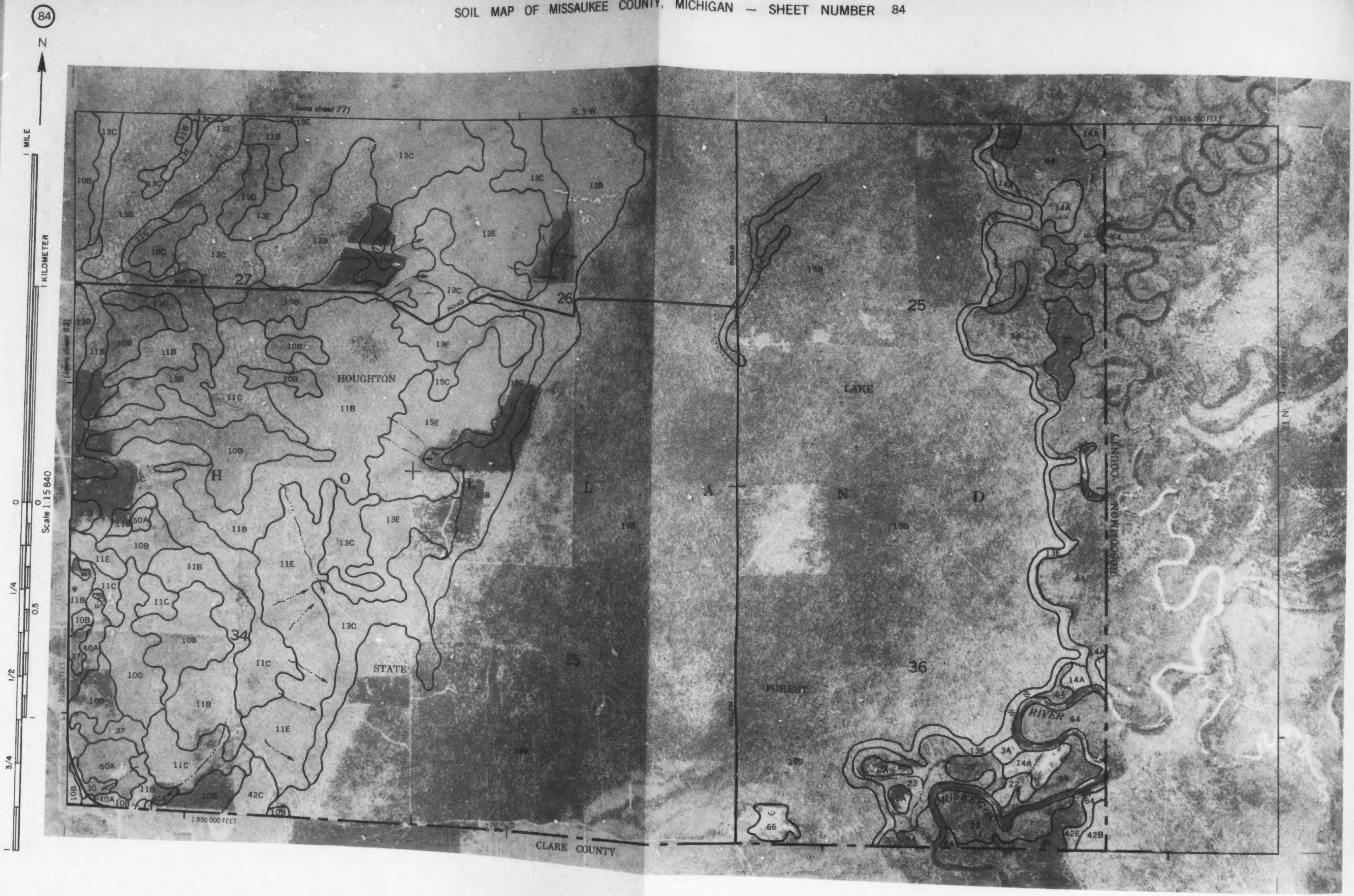


83
N
(Joins sheet 76)
(Joins sheet 82)
R. 6 W.
R. 5 W.
T. 21 N.
STONEY CORNER
ROAD
LIBERTY
HOUGHTON
LAKE
STATE
FOREST
CLARE
COUNTY
25
28
29
30
31
32
33
11B
11C
13B
13C
10B
10C
3A
14A
16A
20
22
40A
42B
42C
46
64
65
66
11E
7
MILE
KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:15 840

This soil survey map is compiled on 1980 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service

Coordinate grid ticks and land division corners, if shown, are approximately positioned

SOIL MAP OF MISSAUKEE COUNTY, MICHIGAN — SHEET NUMBER 84


84
N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
0.5
1/2
1
3/4
(Joins sheet 77)
R. 5 W.
1 860 000 FEET
(Joins sheet 83)
310 000 FEET
T. 21 N.
1 850 000 FEET
HOUGHTON
LAKE
STATE
FOREST
H O L L A N D
ROAD
27
26
25
34
35
36
RIVER
MUSKEGON
ROSCOMMON COUNTY
CLARE COUNTY
13C
13E
11B
10B
10C
13B
11C
15C
15E
19B
11E
50A
40A
37
30
42C
14A
64
3A
22
20
42E
42B
66

This soil survey map is compiled on 1980 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

MISSAUKEE COUNTY, MICHIGAN NO. 84